L Number	Hits	Search Text	DB	Time stamp
-	13660	((((bluetooth and infrared) same (mobile cell$5 or portable)) and bar adj code) and rf adj tag) abd magnetic adj strip	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/24 17:43
-	1047	(bluetooth and infrared) same (mobile cell$5 or portable)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/23 14:12
-	766	((bluetooth and infrared) same (mobile cell$5 or portable)) and identif$6	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/23 14:12
-	435	(bar adj2 code) near30 ((mobile cell$5) adj "3" phone)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/23 17:19
-	200	(bar adj2 code) near30 ((mobile cell$5) adj3 phone)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/23 17:17
-	2993	(455/410,411,418,41.1,41.2,41.3,556.1,558).CCLS.	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/24 20:05
-	20077	((mobile cell$5) adj phone) and ((bar adj "3" code) or (rf adj3 tag))	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/25 10:04
-	20338	((mobile cell$5) adj2 phone) and ((bar adj "3" code) or (rf adj3 tag))	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/25 10:04
-	1891	((mobile cell$5) adj23 phone) and ((bar adj3 code) or (rf adj3 tag))	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/25 10:04
-	1856	((mobile cell$5) adj3 phone) and ((bar adj3 code) or (rf adj3 tag))	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/25 10:05
-	1576	(((mobile cell$5) adj3 phone) and ((bar adj3 code) or (rf adj3 tag))) and (identi$7)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/25 10:08
-	109	((((mobile cell$5) adj3 phone) and ((bar adj3 code) or (rf adj3 tag))) and (identi$7)) and 455/$.ccls.	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/25 10:23
-	51	(((((mobile cell$5) adj3 phone) and ((bar adj3 code) or (rf adj3 tag))) and (identi$7)) and 455/$.ccls.) and (location near15 (transceiver device))	USPAT; US-PGPUB; EPO; JPO; DERWENT	2004/02/25 10:25

US006175860B1

(12) **United States Patent**
Gaucher

(10) **Patent No.: US 6,175,860 B1**
(45) **Date of Patent: Jan. 16, 2001**

(54) **METHOD AND APPARATUS FOR AN AUTOMATIC MULTI-RATE WIRELESS/WIRED COMPUTER NETWORK**

(75) Inventor: **Brian Paul Gaucher**, New Milford, CT (US)

(73) Assignee: **International Business Machines Corporation**, Armonk, NY (US)

(*) Notice: Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

(21) Appl. No.: **08/978,982**

(22) Filed: **Nov. 26, 1997**

(51) **Int. Cl.**[7] **G06F 15/16**; H04M 11/04

(52) **U.S. Cl.** **709/208**; 709/223; 455/3.3; 340/310.01; 340/310.02; 340/310.06

(58) **Field of Search** 709/200.08, 200.09, 709/208, 223; 340/310.01, 310.06; 370/310, 312, 339, 338; 348/8; 455/6.2, 6.3, 3.3

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,429,299	*	1/1984	Kabat et al.	340/310
5,432,838	*	7/1995	Purchase et al.	379/55
5,682,379	*	10/1997	Mahany et al.	370/311
5,768,508	*	6/1998	Eikeland	709/202
5,838,226	*	11/1998	Houggy et al.	340/310.01
5,838,266	*	11/1998	Houggy et al.	340/310.01
5,909,544	*	6/1999	Anderson, II et al.	709/208
5,909,554	*	6/1999	Anderson, II et al.	395/200.38
5,910,776	*	6/1999	Black	340/825.35
5,929,748	*	7/1999	Odinak	340/310.01
5,999,979	*	12/1999	Vellanki et al.	709/232

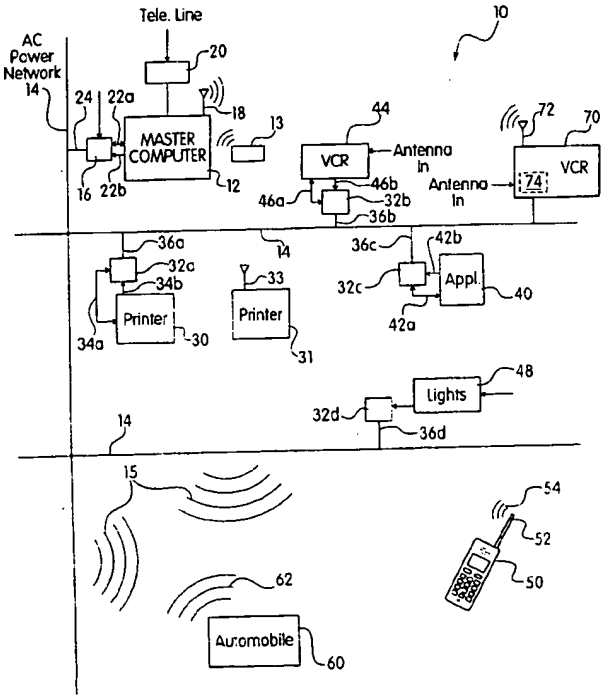
* cited by examiner

Primary Examiner—Dung C. Dinh
Assistant Examiner—Bradley Edelman
(74) *Attorney, Agent, or Firm*—F. Chau & Associates, LLP

(57) **ABSTRACT**

A method and apparatus for implementing a wireless/wired computer network in an indoor environment with inherent reliability is disclosed. A master network box connected to an AC power network and a master computer generates an RF field around the computer, the home, and AC power network. The integration and implementation of additional devices to the established network is made through additional appliance boxes. Once introduced into the generated RF field, or connected to the AC power network, the additional device is automatically and seamlessly registered and configured into the network without requiring any user intervention. The network is capable of multiple modulation schemes for providing robust wired or wireless communication for various devices which have different power and data rates. The programming of the master computer enables the automated registration of additional devices, and can provide superior control over the devices connected to the network, either via the AC power network, or via RF wireless transmission through the multiple modulation schemes.

30 Claims, 4 Drawing Sheets



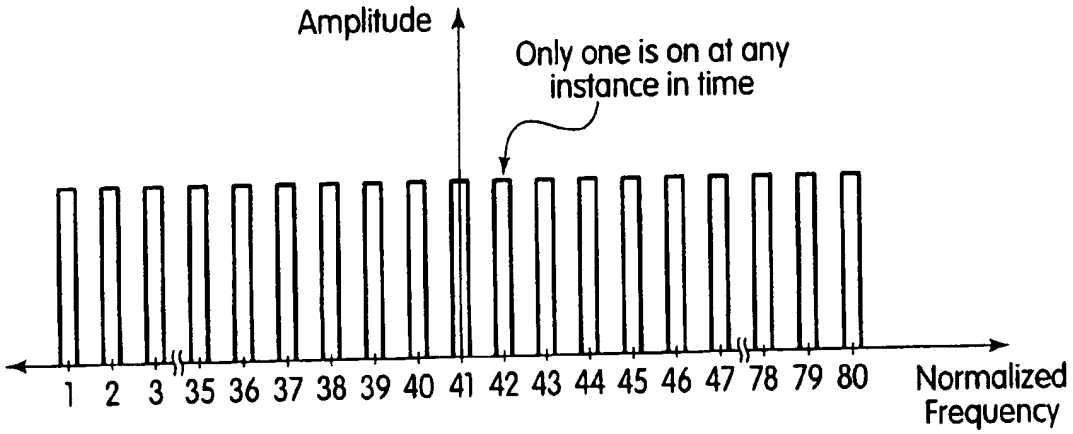

Amplitude
Only one is on at any instance in time
1 2 3 35 36 37 38 39 40 41 42 43 44 45 46 47 78 79 80
Normalized Frequency

Fig. 1

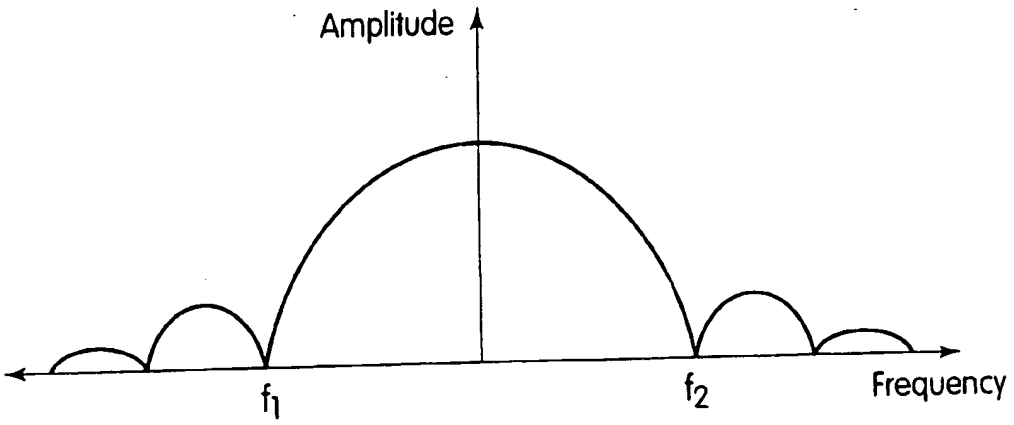

Amplitude
f_1
f_2
Frequency

Fig. 2

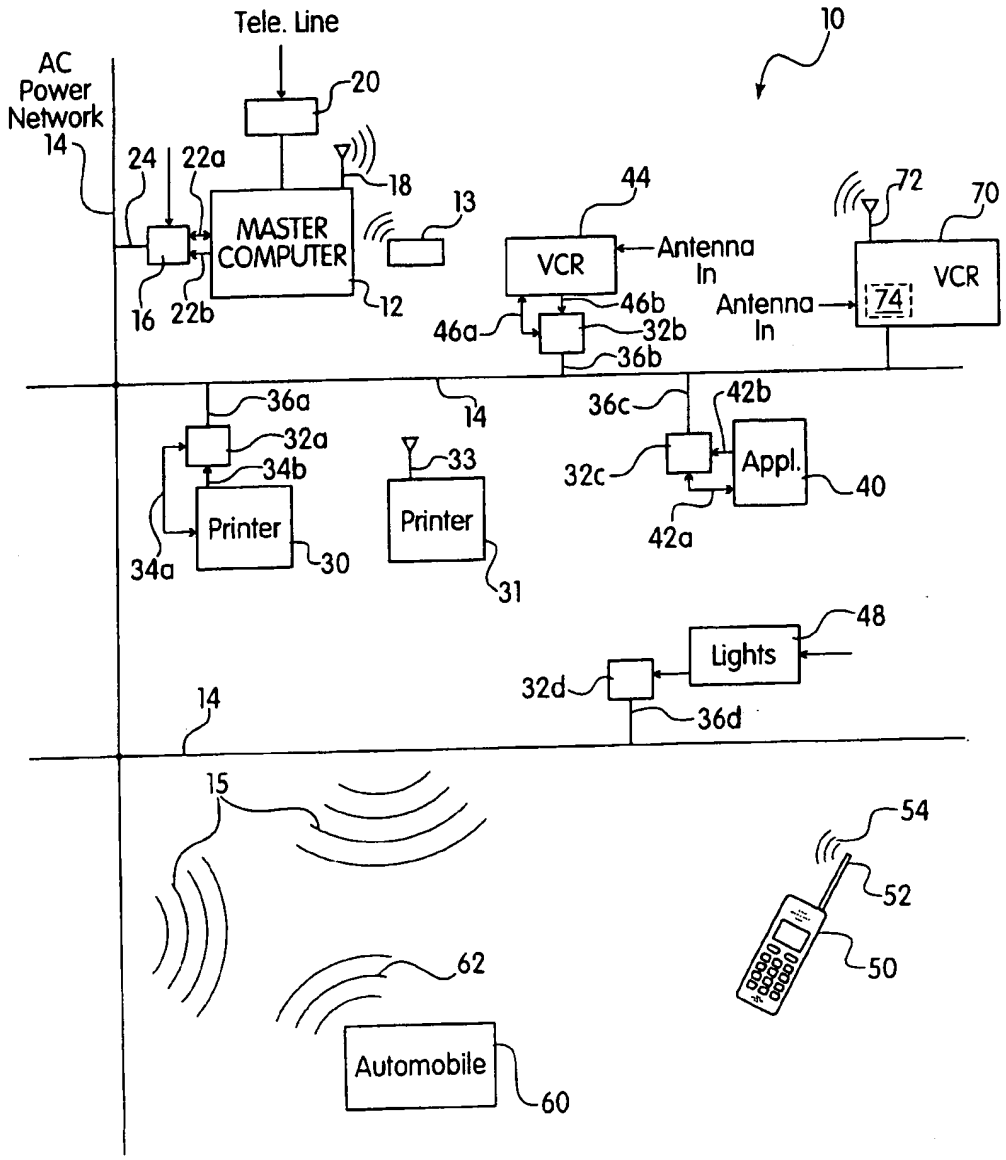

Tele. Line
10
AC Power Network 14
20
24
22a
18
13
MASTER COMPUTER
12
16
22b
44
VCR
Antenna In
46b
46a
32b
36b
72
70
VCR
Antenna In
74
14
36a
32a
34b
Printer
30
34a
33
Printer
31
36c
42b
32c
Appl.
40
42a
48
Lights
32d
36d
14
15
54
52
50
62
Automobile
60

Fig. 3

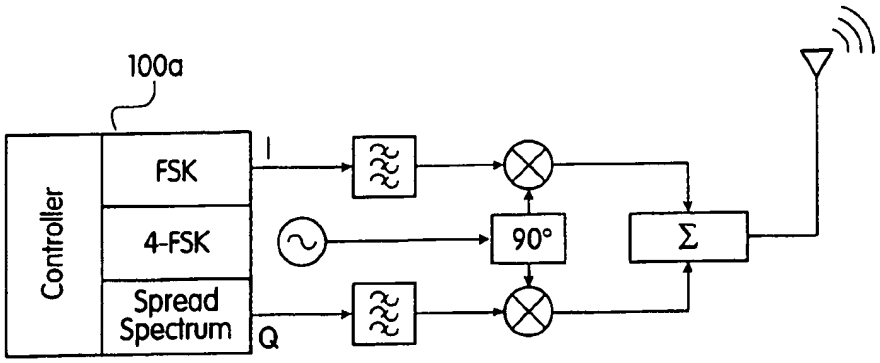

100a
Controller
FSK
4-FSK
Spread Spectrum
I
Q
90°
Σ

Fig. 4

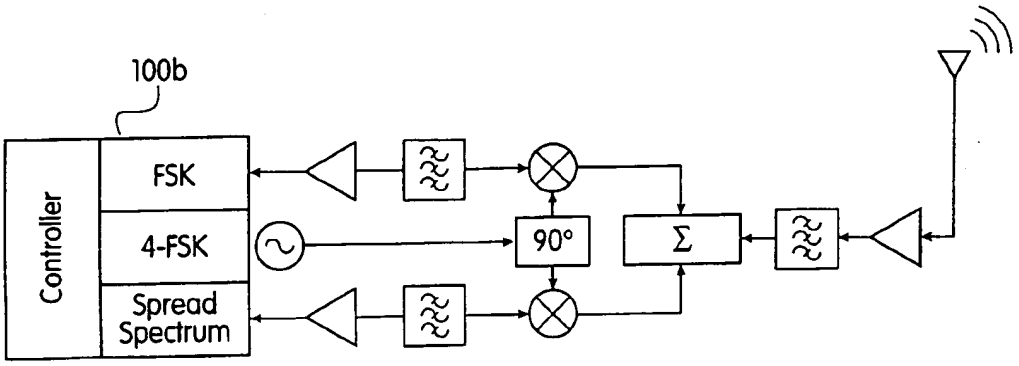

100b
Controller
FSK
4-FSK
Spread Spectrum
90°
Σ

Fig. 5

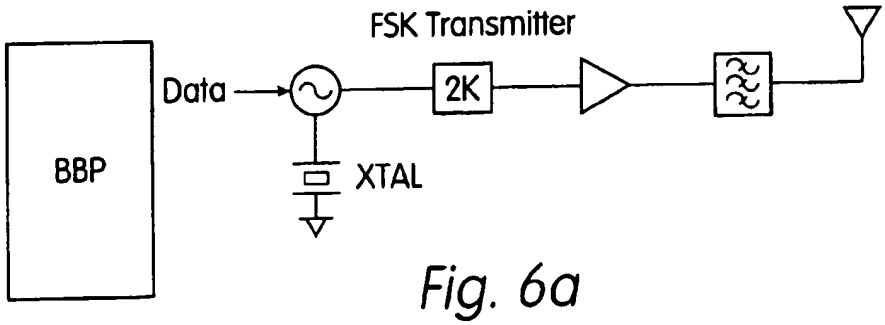


Fig. 6a

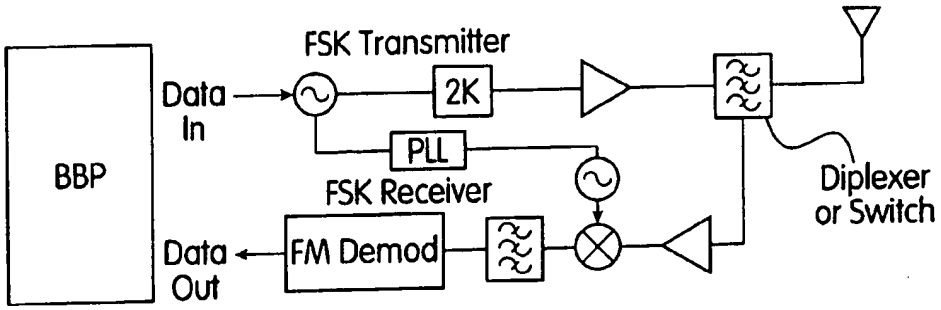


Fig. 6b

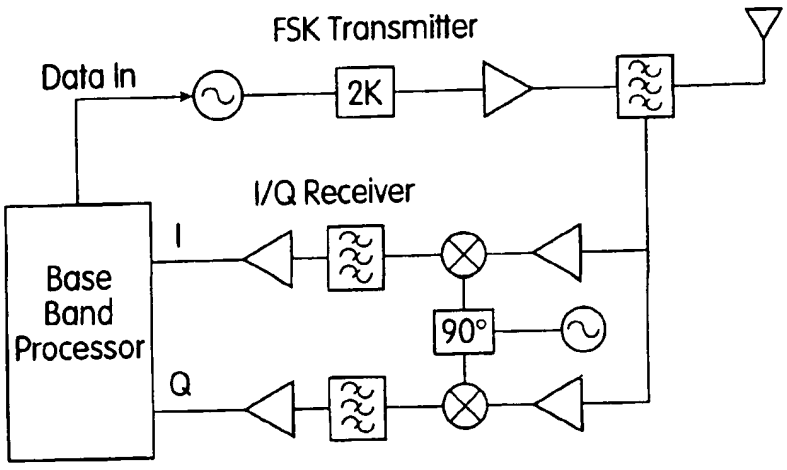


Fig. 6c

METHOD AND APPARATUS FOR AN AUTOMATIC MULTI-RATE WIRELESS/WIRED COMPUTER NETWORK

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to computer networks. More particularly, it relates to an automatic multi-rate wireless/wired computer network using a combination of wireless communications and an AC power network.

2. Prior Art

The ability to provide cost effective performance solutions for computer networks is consistently being sought by the computer industry. To date, there is not a single device on the market that can handle even the simplest task of wireless control in a broad sense. There are a few single application products that address very specific areas such as wireless mice, or wireless LAN.

The wireless products that have been brought to market are unreliable, and are not as good as a wired product, no matter what their claim. In addition, the automation of these products is not existent. That is, they generally require extensive user intervention to install, configure and get running. In addition, the market has demonstrated that network systems, and additional implementations must be transparent to the user.

Currently, there is not a product on the market that allows the use of the appropriate radio solution (i.e., speed MAC/protocol for a particular need that is flexible enough to cover most other needs as well.) For example, a user does not need a high cost radio and associated elements for low cost type applications (e.g., a mouse), but that is necessary for high-speed LAN access. Thus, there is a need for these different systems to be rolled into one, such that multiple modulation schemes for the varying complexity of devices can be implemented in a single piece of hardware, and whose cost is proportional to the function currently being added.

Historically, there are a limited number of modulations available and systems are typically built around one. Typical modulations used include; AM. And the related QAM FM, and the related FSK, GMSK, MFSK PSK and the related BPSK, QPSK, and M-ary PSK. Within the confines of the FM domain are the related FSK, GMSK, and M-ary FSK. In addition, the PSK modulation family is directly related to FSK via mathematical relation of differentiation or integration for the reverse relation.

Beyond these modulations, there is another family now popularized as Spread Spectrum. These have the properties of robust communications while in harsh electronic environments, such as near other radio systems, or interference such as a microwave oven, etc. They also allow transmission of higher power levels since their output is "spread" over many frequencies. Essentially, there are two spread spectrum modulations, both of which are related to the FM and PSK families discussed earlier. The FM relation is what is called Frequency Hopping (FH), whereby data is mapped into the frequency domain and spread over 80 or more frequencies as illustrated in FIG. 1. The pseudo random mapping is a known sequence to both the transmitter and receiver, therefore the receiver can un-map the hopped frequencies back to the original data sequence. The second family of PSK related modulations is called Direct Sequence Spread Spectrum (DSSS). Here the original data sequence is re-mapped into phase changes rather than frequency changes. These show up in the frequency domain as looking like a Sinc function or sin x/x as shown in FIG. 2.

The FCC imposes certain restrictions on the use of both transmitted power and bandwidth. Power is related directly to the operable distance a device can work over, while bandwidth affects the data rate or speed of communications. One can only push the data rate up until the limit of the FCC bandwidth of a particular band is reached, then additional techniques need to be implemented to go beyond that, such as higher complexity modulations like M-ary PSK, or M-ary FSK or data coding techniques.

Cost sensitivity is also a clear market driven requirement. The cost must be proportional to the function the system provides. A system that can provide simple mouse interface must not cost much more than one would have to pay for the wired equivalent, yet the system must be expandable to higher level of function and speed with proportional cost.

Thus, it is apparent that there is a need for a wireless computer system which includes both protocol and hardware, which is capable of multiple modulation schemes and is simple in setup, operation and cost. The network must be expandable as the user requires, and must be transparent to the user. This means, after software installation, the user does nothing except turn on the components and they do the work of configuration within the wireless environment around a computer and the AC power network. The computer will be able to implement the simplest of tasks such as the wireless mouse and joystick to the more complex task of wireless local area networks.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an automatic multi-rate wireless/wired computer network that creates both a wired (via AC power line) and a wireless network (via radio) around the computer with which new devices can be seamlessly added, without significant human intervention.

In order to achieve the above object, network boxes and respective protocol are implemented into an indoor environment such as a home or office. According to an embodiment of the invention, an intelligent RF field is created around the computer system and the entire AC power network of the indoor environment. Through the use of radios and the AC power network as both a receiving and transmitting antenna, and the support of several wireless communication protocols, the network system enables the implementation, connection and control of a diverse group of products to the network without requiring user intervention and/or configuration.

To implement the network according to an embodiment of the invention, a master network box is connected between a master computer and the indoor AC power network through connection to an AC outlet. The network box creates the RF field that is the backbone of the network. Additional network boxes, or appliance boxes, are added to other appliances in the indoor environment which enable those appliances to be controlled and operated through the master computer. The appliance boxes include an AC power connection, and can include a data bus (e.g., PCI or USB) for the two way communication of data between the network and the appliance to which it is connected. In an alternative embodiment of the invention, the appliances themselves can be fabricated with the network connection protocol contained therein, and a data bus port contained thereon.

The master network box and the master computer connected thereto are capable of communication on various channels to accommodate communication with a wider variety of additional devices. The communication system

implemented by the master network box include MAC (media access channel) protocol, the physical media to transport information, and the modulation method for transmitting over the media. The master network box with master computer supports the following modulation functions: 1) low data rate FSK channel communication; 2) higher data rate 4-level FSK channel communication; and 3) time/data critical spread spectrum communication channels. In addition, the master network box provides the AC power line communications link. These four functions are based on four separate transceivers in the master network box, each occupying a specific number of channels to meet the FCC rules for its band.

In an embodiment of the present invention, the use of multiple modulations in hierarchical form, allows a communications network to be built in elements, beginning with either simple or complex functions, but always with the minimum hardware (i.e, cost and simplest implementation, to accomplish a particular function). Through the use of software programmability, multiple modulation techniques can be employed within a single piece of hardware.

An appliance box is connected between the AC power supply and all appliances in the household to be controlled and implemented into the network. When a new system component is added with the required connection box and is within the confines of the created field, it is automatically found and registered within the system. These components include, but are not limited to, low data rate items such as mice, joysticks, medium data rate items such as keyboards, POTs modems, phones, printers, cameras, and high data rate items such as LANs, disk drives, and printers.

In another embodiment, a PDA device, (e.g., cordless phone or cellular phone) can be used to contact the master computer either through a modem and telephone line connected thereto, or if within the specific range, through the RF field created by the radios and/or the AC power network. The PDA device can enable the user to use voice commands or DTMF commands to control features of the network from remote locations, such as, for example: turning on selected lights; starting an oven to prepare a meal; activating or monitoring security systems, watering the lawn, controlling a VCR to record a particular program; and environmental control over the indoor environment. In other embodiments, the system can include RF ID tags associated with various devices such that when the device enters the RF field emanating from the AC power network, the device is automatically registered in the master computer, and any information relating to that device can be accessed through the master computer. One could envision home inventory done this way.

Each appliance box includes a unique registration identifier for purposes of selectively identifying the connected appliance, and providing the necessary communication protocol to the master computer. This identifier code includes enough information for the master to know what class of device it is, and what communication protocol it prefers. The number sequence of the identifier code classifies it into certain communications categories, such as, but not limited to, single or bi-directional communications, low speed FSK rates, high speed low power FSK, high power spread spectrum communications etc. The registration identifier will include information as to the remote device's ability to back off in data rate, and also includes information as to whether a remote device requires asynchronous or Isochronous communications (i.e., can tolerate delays in the exchange of information or must have essentially continuous service as in the case of voice). Additional coding is used to help the data make it through the channel, such as, for example to provide the master with a way to synchronize itself to the remote device and know whether an error in the received data is made. To allow for synchronization, there is a pre-amble added to the sequence of bits.

The use of the AC power line radiating between 1 and 30 MHZ and picked up by RF system and the reverse link as well, is supported by an embodiment of the present invention. The FCC allows the AC power line communication systems to radiate a certain level of RF field. In addition, the system utilizes this leakage field as part of the communication system.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of this invention, and many of the attendant advantages thereof, will be readily apparent as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings, in which like reference symbols indicate the same or similar components, wherein:

FIG. **1** is a graphical representation of the FM relation called Frequency Hopping (F.);

FIG. **2** is a graphical representation of the direct sequence spread spectrum in frequency domain;

FIG. **3** is a schematic block diagram of the wired/wireless computer network according to an embodiment of the present invention;

FIG. **4** is a block diagram of a multi-modulation transmitter according to an embodiment of the present invention;

FIG. **5** is a block diagram of a multi-modulation receiver (demodulator) according to an embodiment of the invention;

FIG. **6***a* is a block diagram of a first class of appliance network connection box according to an embodiment of the present invention;

FIG. **6***b* is a block diagram of a second class of appliance network connection box according to an embodiment of the present invention; and

FIG. **6***c* is a block diagram of a third class of appliance network connection box according to an embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIG. **3**, the multi-rate wireless/wired computer network **10** is shown. The system is implemented on an AC power network **14** which is situated in an indoor environment (e.g., a home or office). A master network box **16** is connected to the AC power network through a standard AC power connection **24**. This connection can be a standard AC power cord, or can be any other suitable known type of connection device. Network box **16** is connected to a master computer **12** using AC power connection **22***b* and a data bus connection **22***a*. The data bus can be any suitable known type of data bus, such as, for example, a PCI, CEbus, and USB. Computer **12** is connected to a telephone line via a modem **20**, and network box **16** is connected to the telephone line through from a household RJ-11 type connector. Network box **16** can be connected to a telephone line with any other suitable known type of connection, for example, it could be hard wired to the telephone line, or connected thereto via another wireless connection.

Computer **12** is programmed with software to enable it to perform according to described invention. The software will

be on a CD ROM or floppy disk and is installed when setting up the network. Upon installation, computer **12** is interrogated to determine its operating system, and then prompts the user with questions to configure the network properly. An example of such questions could be "is a phone to be included in the network?". Once installed, a group of relocatable icons are added to the screen. Each device registered on the network is displayed in the icon group and given a number. If a problem occurs with a particular device, a question mark will appear over the icon of that device. When a device is in use, a moving arrow appears over the respective icon to represent operation.

Additional information as to the network operation is always available to the user. For example, a meter that reflects a particular devices utilization of the channel can be included to provide fast reference as to the overall operation of the network and available channels. If all the devices on the network were fully utilized, the meter would be full.

Some of the icons presented to the user will have multiple levels of menus associated with them to control items like speed, priority, and user dependent settings such as, for example, temperature settings in the home. Through the application of these icons, all settings and control of the various devices connected to the network is provided. In addition, the network can control an internal security system and enable the user to selectively activate or deactivate respective parts of the system.

Network box **16** sets up a high-speed (1–10 Mbps) communications network using the AC power network. In addition, network box **16** creates and intelligent RF field **15** around computer **12** and the entire AC power network **14**. This network is the backbone of the network communication system, and is capable of transmitting over the air or the home AC wiring.

The system includes additional appliance boxes **32***a*–**32***d* for connecting different types of appliances to the network. Each appliance box includes a unique registration identifier for purposes of selectively identifying the connected appliance, and providing the necessary communication protocol to master computer **12**. In addition, the appliance boxes that are capable of two way or bi-directional communication, include a data port for communicating over a data bus. Appliance box **32***a* is connected to the AC power network **14** via a two-way communication connection **36***a*, and connected to a printer **30** using a data bus connection **34***a* and an AC power connection **34***b*. In this configuration, master computer **12** can utilize printer **30** by sending the respective data via the created network. In an alternative embodiment, printer **31** includes the network connection protocol internally, and can be automatically registered into the network through the RF field **15** via antenna **33**. Additional appliances can be connected anywhere in the AC power network using appliance boxes. For example, an appliance **40** can be connected to the AC power network via appliance box **32***c*. The appliance **40** can be any household or office appliance, and is connected to box **32***c* through an AC power connection **42***b* and a data bus connection **42***a*. Similarly, a VCR **44** or lights **48** can be connected to the network using the respective appliance boxes **32***b* or **32***d*.

Once connected to the network, VCR **44**, appliance **40**, and lights **48** can be selectively controlled through master computer **12**.

As mentioned earlier with respect to printer **31**, it is envisioned that the appliance box hardware and connection protocol be implemented into the appliances themselves. For example, a VCR **70** can contain the hardware and communication protocol **74** required for network integration. Thus, once VCR **70** is plugged into an AC power outlet in the network, it may transmit its registration identifier to master computer **12**. VCR **70** may also include an antenna **72** for enabling RF integration into the network. Thus, it is apparent that this feature would lend itself to easier installation, and require less user intervention for setup and configuration.

With the RF network established by network box **16**, an RF field **15** is generated around the home by virtue of the AC power network **14** and radios, both in and outside of indoor environment. Through the application of this field, once a device comes into the confines of field **15**, it can be automatically registered into the network, and any integral information relating to the device can be transferred to master computer **12**, and acted upon accordingly. This is due to the fact that master computer **12** constantly monitors the entire network, including the RF field **15**. For example, when an automobile **60** drives into the garage or within the confines of field **15**, master computer **12** recognizes the automobile and can download information such as, for example, the number of miles traveled since your last oil change. In addition, the automobile's existing sensors can be used to provide master computer **12** with other diagnostic information, such as, for example, scheduled maintenance, brake wear, daily mileage, business mileage, gasoline fill-ups, etc. This network communication, can further enable a user to program a future trip in the master computer, and have that data transferred to the automobile's GPS system. The GPS system can then be automatically programmed accordingly. Once any data is stored in master computer **12**, it can be transferred to another computer (e.g., office computer), or can be simply stored for further reference or processing.

Additionally, system **10** includes at least one PDA device **50** for enabling the control of the networked indoor environment from a remote location. PDA can be any suitable known PDA device, and can include, for example, a cordless or cellular telephone. If PDA **50** is within the confines of RF field **15**, it can be automatically registered into the network, and any input commands will be acted upon accordingly. If, PDA **50** is not within the confines of RF field **15**, the user can contact master computer **12** through the telephone line, via modem **20**. Once connected, the user can verbally instruct the master computer to perform various functions, such as, for example, scheduling functions of the user, or simple control functions such as "turn on lights", "activate the oven", "activate the dishwasher or laundry machine" etc.

As mentioned, the PDA can be used for scheduling functions. For example, one speaks into the PDA requesting to schedule an event and the system recognizes that vocabulary and updates your calendar with the time and tagged voice message that can be converted to text in the master computer **12**. Offline, the system can call your office and update your office calendar automatically. The PDA can also act as a homing device letting the master computer **12** know where you are within the generated radio or AC power network RF field **15**, and can route information directly to the user. The homing aspect can enable the master computer to turn on and off lights as you enter and leave rooms, respectively without the need for human intervention. Once the PDA **50** is turned off, or outside the range of the RF field **15**, it automatically enters a sleep mode, or returns to its cellular function if so enabled.

The PDA can make and receive telephone calls routed through the master computer **12**. The calls can be logged and screened using caller ID. The PDA can be loaded with e-mail messages currently waiting to be read, and the user can

selectively read any, all or none of the waiting messages. The PDA could even voice synthesize those messages, and play them over the PDA while the user goes about their ordinary business in the home. This feature also extends to voice mail and other messaging systems.

Future generations of the PDA might include the ability to receive and send video information. For example, one may be able to take a simple snap shot of a document and have it transferred to the master computer **12** for character recognition, etc. It could also be used to take snap shots of people, feed business cards into the system, and can be used for building entry/security, address book updating, etc.

With the implementation of this system, additional services can be provided to the user for controlling appliances within their home or other indoor environment. For example, Internet services can be purchased whereby the service provider can automatically program VCR **44** to record selections the user would select from a menu.

Communication Protocol

As explained earlier, through the use of software programmability, multiple modulation techniques can be employed by a single piece of hardware. This process can go in either of two directions: 1) utilizing the programmability, only making software appropriate for each class of devices, but the same IC, modified only by memory required; or 2) by optimizing the actual die or chip size for each class of devices. Using a single device and modifying code only makes the device proliferate faster, but at a slightly greater cost for the low function class of devices. Since volumes drive cost, the more one can cause a device to proliferate the lower the potential cost. In the case of 2), this system optimizes the complexity (i.e., implementation difficulty), actual Si (silicon) or SiGe (Silicon Germanium) are (hardware cost) with the functional capabilities required. For example, a mouse function requires minimal data rate, yet in accordance with the present invention, the same controller/processor as used for higher speed and complexity in a device like the wireless LAN, is used for the mouse. This is done by taking advantage of Si and SiGe design tools at the device level, where function macros can be developed that result in specific function IC's. This allows a designer to create blocks that can be used as primitives and added to later for additional functionality. The designer can now create Si or SiGe macros with simple functions that use only a small amount of Si. More complex functions would be built using that same primitive added to additional Si macros to complete the higher level function.

FIGS. **4** and **5** show the implementation of the transmitter and receiver portions ot an exemplary communication system according to an embodiment of the network box **16** and the more complex of the appliance boxes. FIG. **4** shows the modulator or transmitter portion, and FIG. **5** shows the de-modulator or receiver portion. As shown, both the transmitter and receiver include a controller **100***a* and **100***b*, respectively, which enable three different modulation schemes to operate depending on the type of device and complexity of functions being performed. The highest-level complexity transmitter (FIG. **4**) is capable of the simplest FSK to the most complex Spread Spectrum modulations. The basic RF hardware involved is made up of I (in-phase) and Q (quadrature Phase) modulators. In actual implementation, for example, the wireless mouse would make use of the FSK level of communications and not anything beyond that, and therefore would not require additional Si area.

The lowest cost example is the first "primitive" which is FSK modulation. The lowest cost system on the market is FSK or BFSK, very similar to FM, therefore, all radios in this proposed network will be capable of communicating using this most basic form of modulation. For example, functions like wireless mouse, joystick, and keyboards will utilize this scheme. These are typically low data rate devices not requiring more than 10's to 100's kbps in data transmission. Next in the hierarchy of data requirements would be those devices requiring more than 100's kbps. For those devices exceeding 1 Mbps, a 4 level FSK scheme is proposed. This can still meet the requirements of the FCC bandwidth, but yet go as high as 2–4 Mbps. For those systems requiring long distance operation like telephony and remote networking, it is proposed to implement spread spectrum. The simple FSK modulation includes the class of FSK called frequency chirp FSK that provides for very robust radio communications. As described earlier, for the lower data rates it would be frequency hopping while for the higher data rates it would be direct sequence.

Network Setup/Implementation

The master computer **12** serves four major functions: it services the low data rate FSK channel; it services the higher data rate 4-level channels and the time/data critical spread spectrum channels, and finally the AC power line communications link. These four functions are based on three separate RF transceivers and the AC power line transceiver in the Master network box **16**, each occupying a specific number of channels to meet the FCC rules for its band. The controller **100** in the master is the heart of the system, distributing data and control throughout the network, allowing communications from the PSTN to Peer, Peer to Peer, Peer to AC power line, AC power line to PSTN, and of course, master to any device connected to the network.

The network setup begins by starting with the assumption that the master network box **16**, at master computer **12**, is turned on. Once on, network box **16** constantly scans the channels in the FSK mode looking for new or unregistered devices, as well as attempting to service those already registered. If it finds a new unregistered device requesting service, that means the device has been turned on within the field area **15** of master computer **12** and AC power network **14**, and is periodically requesting service. When the master detects a device communicating on this lowest of protocols (i.e., FSK mode), it queries the device asking what it is and its preferred communications mode, similar to that of telephony modems, except the communication starts at the lowest level and works upward. The device responds to the master providing it's unique registration and serial number, coded in ROM or switches set at the factory. This code includes enough information for the master to know what class of device it is, and what communication protocol it prefers. In the case of a wireless mouse, e.g., mouse **13** (see FIG. **3**), where single direction communications is acceptable (i.e., the mouse has no receiver), and the code it transmits at power up and part of every packet, is enough for the master to realize it cannot send out information to the device, but can only receive it. It therefore establishes communications on the channel it was queried on and remains there until the mouse changes frequency, upon which time the process begins again. There can also be a more intelligent mouse that has bi-directional communications capability, which would be recognized by the master who would then take advantage of this fact with more error checking, etc.

As mentioned earlier, each device to be connected to the network has a unique identifier, whose number sequence classifies it into certain communications categories, but not limited to; single or bi-directional communications, low

speed FSK rates, high speed low power FSK, high power spread spectrum communications etc. As described earlier, the single direction devices will periodically broadcast its registration number to the master on a prescribed channel beginning at turn-on. The master filters off all data packets after the registration number and discards them until it has been registered. Once registered, the packets will then be acted upon, such as packets indicating mouse movement etc.

For those devices that are bi-directional, they will remain idle at turn-on, though constantly listening on a beacon channel for information from the master. When a device hears the master for the first time, it waits a random amount of time and then transmits its identifier to the master which will then register the device and service its request periodically at its preferred data rate and modulation, channel allocation, and at a defined power level that is the minimum for robust operation for that device.

This implies that power control is done for each bi-directional device to minimize the impact of this system with any existing system in a home or business such as cordless phones, etc. The power control consists mainly of two points: 1) the ability of the master to measure the signal level of a remote device, typically call RSSI (Received Signal Strength Indicator); and 2) the ability to measure the quality of the signal as measured in error packets, typically Bit or Packer Error rates (BER). Based on a combination of these two, the master computer **12** will computer and request an increase or decrease in power from the remote device. If capable, the remote device will send comparable signal quality information to the master, which will adjust its level up or down accordingly. The update of change is based on an integral measurement, essentially an average over time to keep the power control loop stable. The amount of adjustment will be in steps of roughly 5 dB from a low power of −20 dBm to a high if +20 dBm, at net 40 dB control range. (Not all devices will have this capability or dynamic range).

Registration

The registration process is cyclic in that the master is periodically checking the FSK link for new members as it goes about the process of servicing other devices. After registration is complete, the master continues to service the remote devices at their preferred rate and modulation. If the master detects an error rate too high for a particular device, it can communicate to the device a code that will tell it to reduce the data rate in steps of 3 dB or factors of 2. Not all devices are capable of this level of intelligence, but those that are will respond in an attempt to reduce the overall error rate and increase throughput. The registration identifier will include information as to the remote device's ability to back off in data rate.

The registration identifier also includes information as to whether a remote device requires asynchronous or Isochronous communications (i.e., can tolerate delays in the exchange of information or must have essentially continuous service as in the case of voice). As the number of Isochronous devices (voice channels) goes up, the throughput of the other devices begins to drop. The master will automatically adjust the asynchronous devices downward to accommodate the Isochronous devices. This process will continue until the bandwidth of the channel is exhausted and then no new devices will be accepted into the network, until the requirements of Isochronous devices drop. Then the master will redistribute the bandwidth to the registered devices according to the priority and class device their registration identifier indicates, and then begin accepting new devices if presented.

Another important aspect of registration includes coding that is used to help the data make it through the channel. The registration identifier is coded in such a way as to provide the master with a way to synchronize itself to the remote device and know whether an error in the received data is made. To allow for synchronization, there is a pre-amble to the sequence of bits. Synchronization takes two forms: carrier and data. In the case of spread spectrum modulation, there is an additional step of chip level synchronization. For example, a 511 Barker code could be used for the master to synchronize to. For the most complex of examples in this system, (i.e., a spread spectrum device), the sequence may be carrier synch, PN synch and bit synch. At this point, the master can read the data given to it, but the possibility of errors occurring still exists. To combat that, an FEC code (Forward Error Correction) may be included. These usually take the form of cyclic codes, well defined in the art. This allows the master and remote devices to communicate in a very robust and reliable manner, correcting most errors as they occur or requesting re-sends of packets that are uncorrectable. This level or robustness is reserved for the upper tier devices and not practical for the low cost, low data rate devices like mice or joysticks. For these lower tier devices, there may be no error checking or just minor error coding such as multiple sends of the same command within a specified time boundary that master computer **12** can interpret. They may be simple cyclic redundancy checks (CRCs) on the next upper tier. In any case, master computer **12** can handle any and all of these while the remote devices are limited to communicating at or below their class.

The remote devices are first designed to work with a master, but if none can be found (i.e., no interrogation was initiated by a master), it can become a simplified master to establish a peer to peer link. For example, a laptop computer equipped with this system could establish a link with a like system by simulating the desired protocol. The registration process would be similar, though limited to its class of device or lower.

MAC/protocol

There are numerous ways a wireless network can access the channel or RF media and they include transmitting at the instance of request, listening before transmitting to avoid collisions with other devices (CSMA-CA), and reserving time slots for communication (slotted Aloha/TDMA) etc. The system of the present invention is a combination of techniques, time division duplex (TDD), CSMA-CA, Frequency Division Multiple Access (FDMA), and Time Division Multiple Access (TDMA). At turn on, each device operates in an FSK mode listening and alternating transmission on a prescribed channel in a pseudo random time division scheme with random back off. This is the registration channel. Once registered, units move to new frequency locations and power levels they are designed to operate at. For some this will mean following a pre-set time schedule of transmissions coordinated by master computer **12**. For others, a coordinated selection of frequencies chosen by the master computer and allocated on a time division basis to all the remotes in that class.

The RF Hardware is a combination of two main classes of devices relating to modulation complexity and directionality. The first class is single direction simple FSK devices that require the minimum hardware configuration, only a transmitter with a single modulator (FIG. 6*a*). The second class of device is the bi-directional FSK line that requires both a transmitter and receiver, though still a single modulator and demodulator (FIG. 6*b*). The last class device is the bi-directional multi-level FSK or spread spectrum transceivers that require dual modulators and demodulators for the I and Q channels (FIG. 6*c*). The actual Si hardware choice can

be just to utilize parts of a single common IC like shown in FIG. 6*c*, or to use an IC of minimum design (FIGS. 6*a* and 6*b*) and save the money saved in Si area. This is an economic choice not technical, and can be made at the time of production, with some estimation of anticipated volumes.

It should be understood that the present invention is not limited to the particular embodiment disclosed herein as the best mode contemplated for carrying out the present invention, but rather that the present invention is not limited to the specific embodiments described in this specification except as defined in the appended claims.

We claim:

1. A method for establishing an automatic multi-rate wireless/wired computer network comprising the steps of:

generating an RF field around a master computer and an AC power network to envelope a location in the RF field;

establishing communication between the master computer and a plurality of different devices connected to the AC power network or a radio device, the plurality of different devices including wired or wireless devices;

scanning the RF field for new devices which have entered the RF field to identify the new devices and establish communication with the new devices; and

controlling said plurality of different devices and new devices, if identified, via the master computer.

2. The method according to claim 1, wherein said step of establishing communication further comprises the steps of:

providing a master network connection between the master computer, the AC power network, or the radio device; and

providing an appliance network box connected between at least one of the plurality of different devices or new devices and the AC power network.

3. The method according to claim 1, wherein the step of scanning includes the steps of:

scanning a plurality of communication channels;

identifying a request for connection to the network from the plurality of different devices;

registering any new devices into the network;

repeating said step of scanning to identify the presence of any additional devices seeking registration connection to the network; and

maintaining communication with each identified device connected to the network.

4. The method according to claim 3, wherein said step of registering further comprises the steps of:

identifying a unique registration identifier for each identified device;

analyzing the registration identifier to determine a preferred communication protocol desired for a particular device; and

establishing communication with each device at the preferred communication protocol.

5. The method according to claim 1, wherein said step of scanning is preformed on low data rate FSK channels.

6. An apparatus for establishing an automatic multi-rate wireless/wired computer network comprising:

a master processing unit;

an AC power network coupled to said master processing unit;

means for generating an RF field around said master processing unit and said AC power network to envelope a location in the RF field;

a plurality of different devices connected to said AC power network, the plurality of different devices including wired or wireless devices;

means for establishing communication between said master processing and said plurality of different devices, said means for establishing communication including means for scanning the RF field to identify and register new devices entering the RF field to establish communication with the new devices and add the new devices to the plurality of different devices; and

means for operating and controlling said plurality of different devices using said master processing unit.

7. The apparatus according to claim 6, wherein said means for generating an RF field further comprises a master network box having a first connection port connected to said AC power network, a second connection port for providing AC power to said master processing unit, and a third data connection port for connecting to a data bus of said master processing unit.

8. The apparatus according to claim 6, wherein said means for establishing communication further comprises:

at least one appliance network box connected between at least one of the plurality of different devices and said AC power network, said at least one appliance box having a unique registration identifier; and

means for registering new registration identifiers identified through said scanning means.

9. The apparatus according to claim 6, wherein said means for establishing communication further comprises means for establishing wireless communication between said master processing unit and said plurality of different devices, said wireless communication means having multiple available modulation schemes.

10. The apparatus according to claim 9, wherein said wireless communication means selects a modulation scheme depending on a preferred data rate of said plurality of different devices.

11. An apparatus for establishing an automatic multi-rate wireless/wired computer network comprising:

a computer including a memory storage device and an operating system;

an AC power network coupled to the computer;

a network box coupled to the computer and the AC network, the network box adapted to generate an RF field around the computer and the AC power network to envelope a location in the RF field;

a plurality of different devices coupled to the RF field such that signals are transmitted to and received through the RF field, the plurality of different devices including wired or wireless devices;

means for establishing communication between the computer and the plurality of different devices, the means for establishing communication including a plurality of protocols adapted to communicate with the plurality of different devices in accordance with a preferred protocol for a particular device, the preferred protocol being established by the particular device; and

wherein the computer includes means for scanning the RF field to identify any registration identifiers not registered in the network; and means for registering new registration identifiers identified through means for scanning.

12. The apparatus according to claim 11, further comprising an appliance network box adapted to provide an RF interface for communicating between the computer and at least one of the plurality of different devices.

13. The apparatus according to claim 12, wherein the appliance network box is connected between a device of the plurality of different devices and the AC power network, the appliance box having a unique registration identifier for identifying an appliance.

14. The apparatus according to claim 11, wherein the plurality of protocols include a plurality of modulation schemes.

15. The apparatus according to claim 14, wherein the plurality of modulation schemes include at least one of FSK, 4-level FSK and Spread Spectrum.

16. The apparatus according to claim 14, wherein one of the plurality of protocols selects a modulation scheme depending on the preferred data rate of each of the plurality of different devices.

17. The apparatus according to claim 11, wherein the plurality of different devices include at least one of a VCR, a light, a telephone, an appliance, an automobile, a wireless communications device, a mouse, a camera, a keyboard, a security system and a printer.

18. An apparatus for establishing an automatic multi-rate wireless/wired computer network comprising:

a computer including a memory storage device and an operating system, the computer including means for scanning the RF field to identify any registration identifiers not registered in the network; and means for registering new registration identifiers identified through the means for scanning;

an AC power network coupled to the computer;

a network box coupled to the computer and the AC network, the network box adapted to generate an RF field around the computer and the AC power network to envelope a location in the RF field;

a plurality of different devices coupled to the RF field such that signals are transmitted to and received through the RF field, the plurality of different devices including wired or wireless devices; and

means for establishing communication between the computer and the plurality of different devices, the means for establishing communication including a plurality of protocols adapted to communicate with the plurality of different devices in accordance with a preferred protocol for a particular device.

19. The apparatus according to claim 18, further comprising an appliance network box adapted to provide an RF interface for communicating between the computer and at least one of the plurality of different devices.

20. The apparatus according to claim 19, wherein the appliance network box is connected between a device of the plurality of different devices and the AC power network, the appliance box having a unique registration identifier for identifying an appliance.

21. The apparatus according to claim 18, wherein the plurality of protocols include a plurality of modulation schemes.

22. The apparatus according to claim 21, wherein the plurality of modulation schemes include at least one of FSK, 4-level FSK and Spread Spectrum.

23. The apparatus according to claim 21, wherein one of the plurality of protocols selects a modulation scheme depending on the preferred data rate of each of the plurality of different devices.

24. The apparatus according to claim 18, wherein the plurality of different devices include at least one of a VCR, a light, a telephone, an appliance, an automobile, a wireless communications device, a mouse, a camera, a keyboard, a security system and a printer.

25. An apparatus for establishing an automatic multi-rate wireless/wired computer network comprising:

a computer including a memory storage device and an operating system;

an AC power network coupled to the computer;

a network box coupled to the computer and the AC network, the network box adapted to generate an RF field around the computer and the AC power network to envelope a location in the RF field;

a plurality of different devices coupled to the RF field such that signals are transmitted to and received through the RF field, the plurality of different devices including wired or wireless devices;

means for establishing communication between the computer and the plurality of different devices, the means for establishing communication including a plurality of protocols adapted to communicate with the plurality of different devices in accordance with a preferred protocol for a particular device, the preferred protocol being established by the particular device; and

an appliance network box adapted to provide an RF interface for communicating between the computer and at least one of the plurality of different devices, wherein the appliance network box is connected between a device of the plurality of different devices and the AC power network, the appliance box having a unique registration identifier for identifying an appliance.

26. The apparatus according to claim 25, wherein the computer includes means for scanning the RF field to identify any registration identifiers not registered in the network; and means for registering new registration identifiers identified through means for scanning.

27. The apparatus according to claim 25, wherein the plurality of protocols include a plurality of modulation schemes.

28. The apparatus according to claim 27, wherein the plurality of modulation schemes include at least one of FSK, 4-level FSK and Spread Spectrum.

29. The apparatus according to claim 27, wherein one of the plurality of protocols selects a modulation scheme depending on the preferred data rate of each of the plurality of different devices.

30. The apparatus according to claim 25, wherein the plurality of different devices include at least one of a VCR, a light, a telephone, an appliance, an automobile, a wireless communications device, a mouse, a camera, a keyboard, a security system and a printer.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,175,860 B1
DATED : January 16, 2001
INVENTOR(S) : Brian Gaucher

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Drawings,
Sheet 3, Figure 5 should appear as follows:

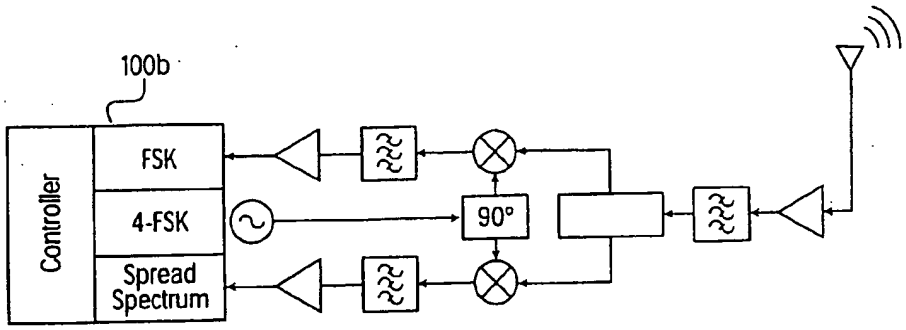


Fig. 5

Signed and Sealed this

First Day of April, 2003

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

US005627517A

United States Patent [19]

Theimer et al.

[11] Patent Number: 5,627,517

[45] Date of Patent: May 6, 1997

[54] **DECENTRALIZED TRACKING AND ROUTING SYSTEM WHEREIN PACKAGES ARE ASSOCIATED WITH ACTIVE TAGS**

[75] Inventors: **Marvin M. Theimer; Roy Want**, both of Mountain View, Calif.

[73] Assignee: **Xerox Corporation**, Stamford, Conn.

[21] Appl. No.: **548,360**

[22] Filed: **Nov. 1, 1995**

[51] **Int. Cl.**[6] **G08B 13/14**

[52] **U.S. Cl.** **340/572**; 340/505; 340/825.49; 342/44; 455/88

[58] **Field of Search** 340/572, 539, 340/505, 825.49, 825.54, 825.31, 825.34, 825.35; 455/73, 88, 89; 342/42, 44, 51; 364/403, 478.01, 479.01; 235/385

[56] **References Cited**

U.S. PATENT DOCUMENTS

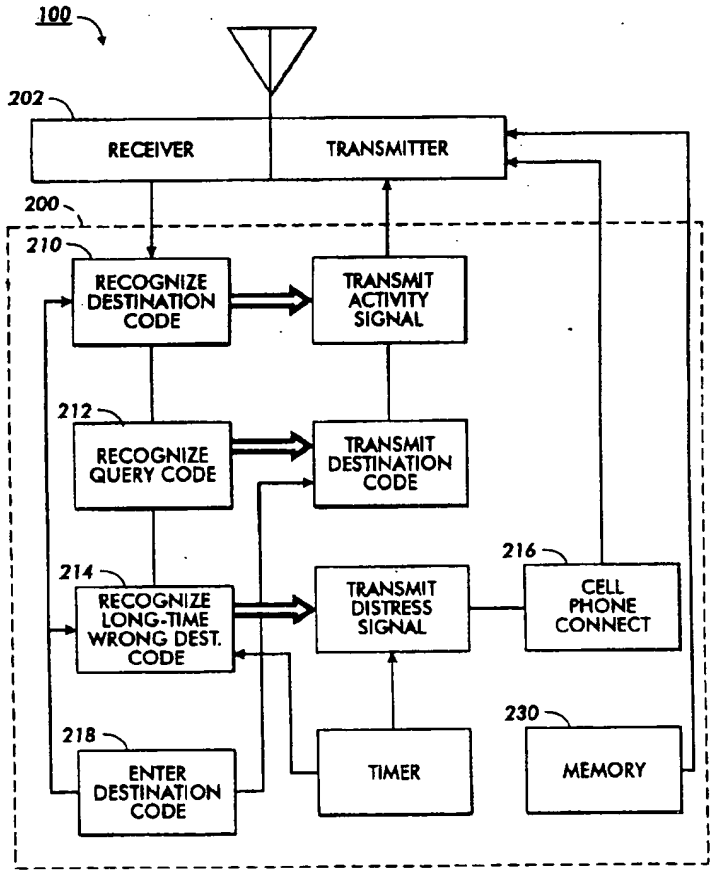
3,772,668	11/1973	Smith	340/572 X
4,068,232	1/1978	Meyers et al.	342/44
4,217,588	8/1980	Freeny, Jr.	342/458
4,275,385	6/1981	White	340/825.49
4,688,026	8/1987	Scribner et al.	340/572
4,832,204	5/1989	Handy et al.	235/385 X
4,952,928	8/1990	Carroll et al.	340/825.54
5,027,314	6/1991	Linwood et al.	364/460
5,122,959	6/1992	Nathanson et al.	364/436
5,347,274	9/1994	Hassett	340/988
5,406,275	4/1995	Hassett et al.	340/933
5,491,486	2/1996	Welles, II et al.	342/357

Primary Examiner—Thomas Mullen
Attorney, Agent, or Firm—R. Hutter

[57] **ABSTRACT**

In a freight tracking and routing system, each individual package is provided with a tag physically attached thereto. The tag includes a radio or infrared transceiver, and a microprocessor. At important nodes at geographical locations within the distribution system, location transceivers broadcast signals representative of their locations. The microprocessor, in response to receiving a desired destination signal, emits a signal commanding external equipment to take the package so that it remains at the desired location. The tags are also capable of being electronically queried, or alternately can emit distress signals when they do not reach a particular location at a particular time.

24 Claims, 3 Drawing Sheets



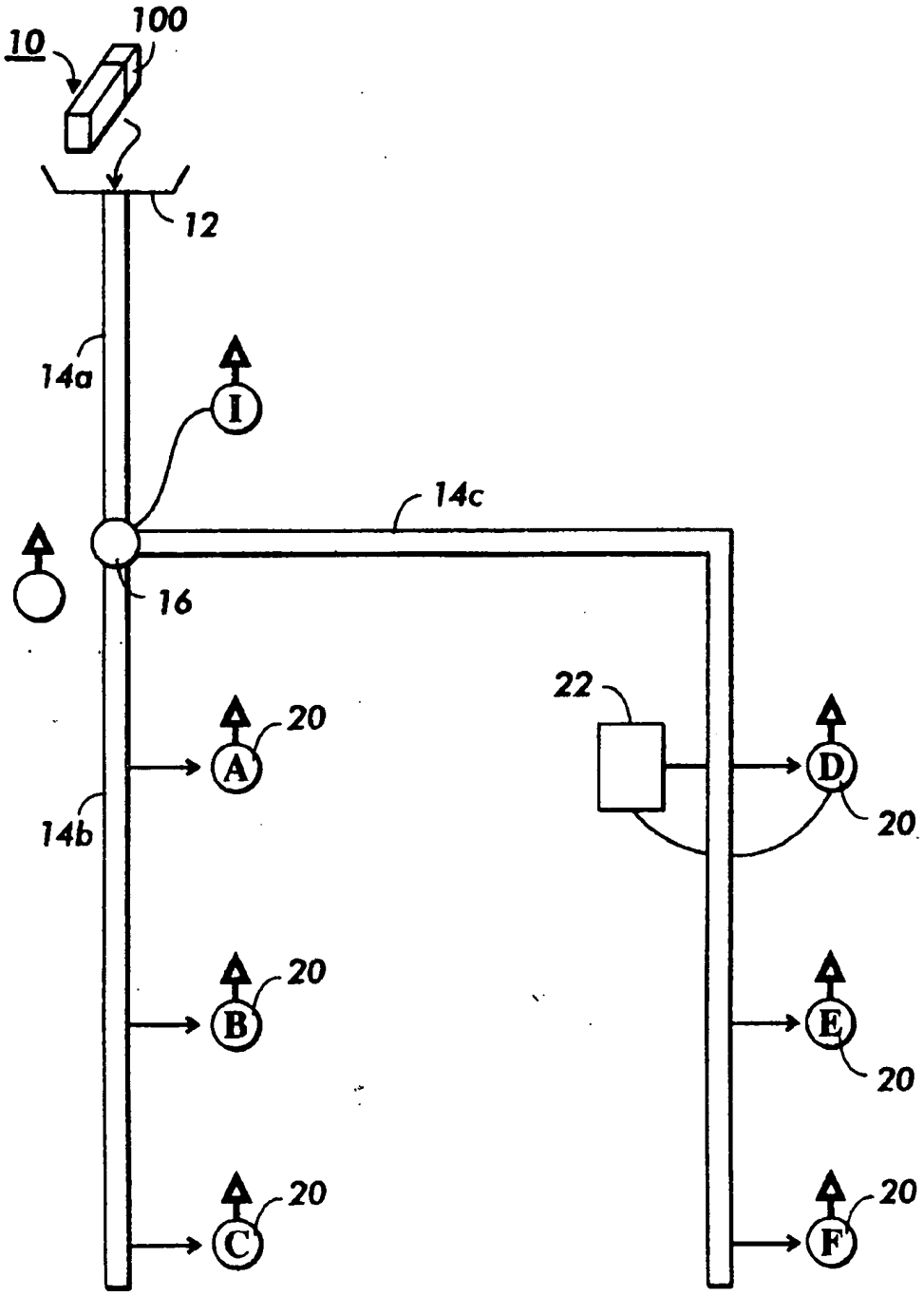


FIG. 1

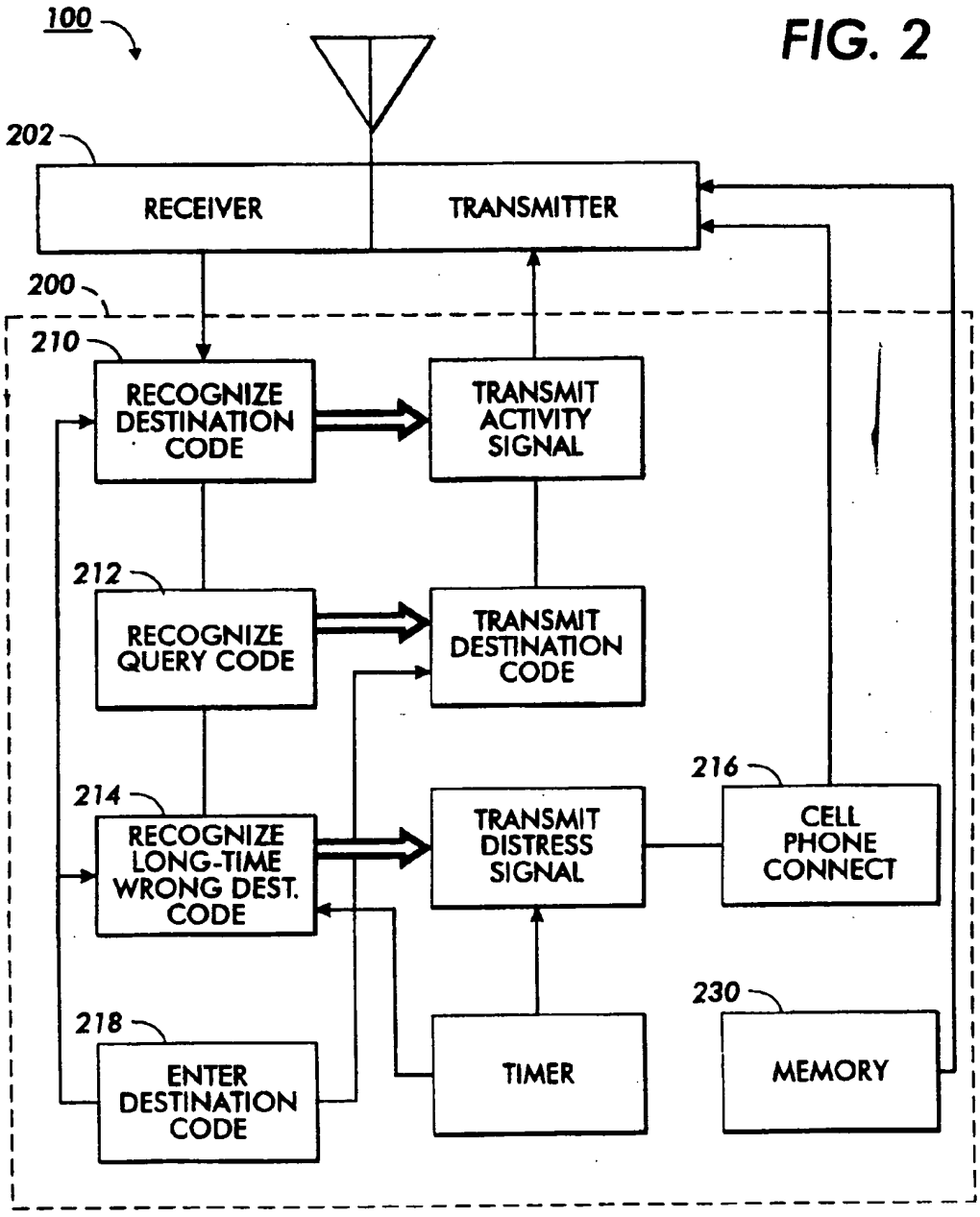

100
202
RECEIVER
TRANSMITTER
200
210
RECOGNIZE DESTINATION CODE
TRANSMIT ACTIVITY SIGNAL
212
RECOGNIZE QUERY CODE
TRANSMIT DESTINATION CODE
214
RECOGNIZE LONG-TIME WRONG DEST. CODE
TRANSMIT DISTRESS SIGNAL
216
CELL PHONE CONNECT
218
ENTER DESTINATION CODE
TIMER
230
MEMORY

FIG. 2

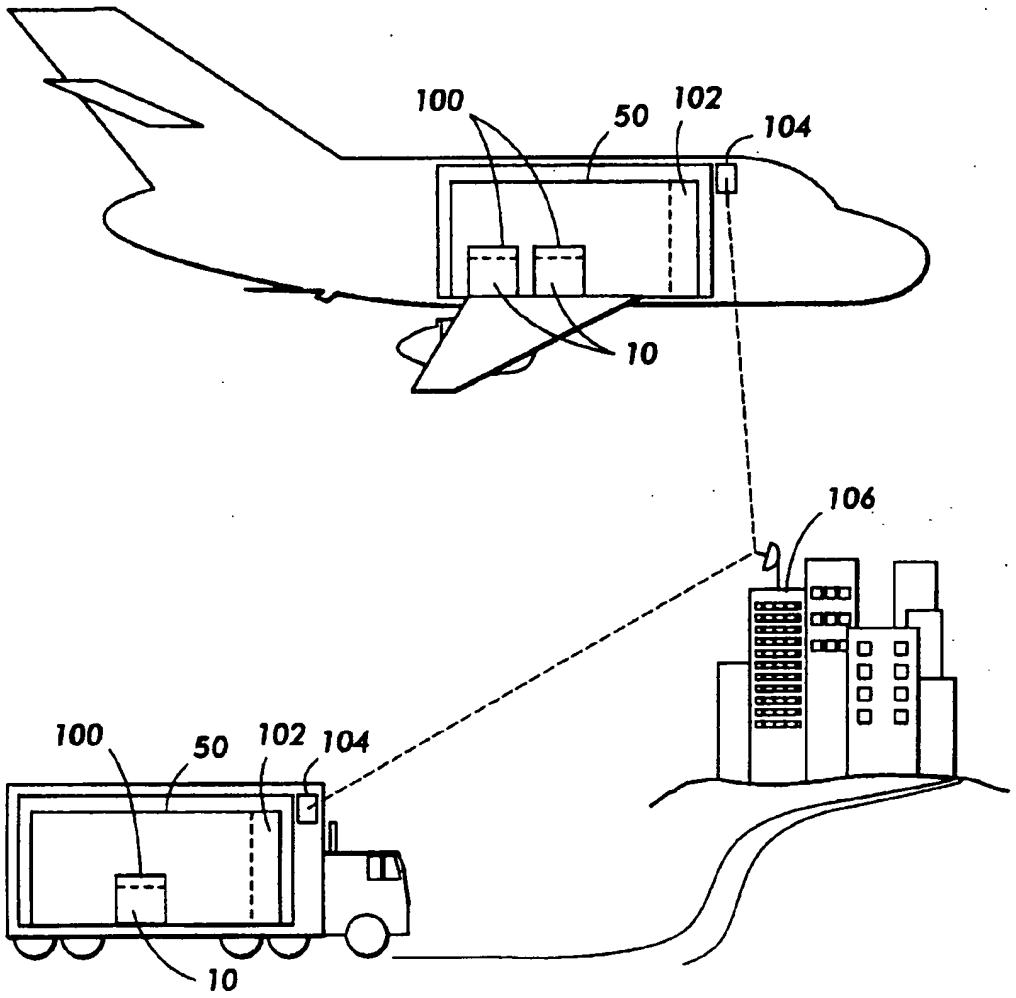


FIG. 3

DECENTRALIZED TRACKING AND ROUTING SYSTEM WHEREIN PACKAGES ARE ASSOCIATED WITH ACTIVE TAGS

The present invention relates to a decentralized package-tracking and routing system, for use in freight-handling and other distribution systems. More specifically, the present invention relates to a tracking system which is largely decentralized, and in which control over the destination of each package mainly resides with each package itself.

Freight tracking systems for tracking the location of large numbers of packages in a distribution system are well-known. Such systems are commonly used as inventory control systems in manufacturing situations and are also common in delivery services such as UPS or airlines. Many such systems common in the art involve the proprietor of the tracking system, such as the post office or airline, identifying individual packages as they enter the system with a special mark peculiar to the system. For example, it is common to check baggage in an airport and have each bag receive a sticker with a bar-code thereon. This bar-code is then used by the airline's own equipment to monitor the passage of the bag through the baggage system. The use of bar codes and other identifying marks typically requires the use of a centralized system which must extend to the borders of the physical system; for example, from the time a bag is being checked at one airport until it is picked up at another airport, one central control common to the entire airline must be able to not only to recognize the bar-code but be able to determine the location of the bag with reasonable precision at any time.

There are certain disadvantages to this commonly-used system. First, there is no reason that a bar-code system dedicated for the use of one system proprietor (such as an airline) could or should be compatible with the bar-code system of another proprietor: a bar-code sticker placed on a bag by an airline could be rendered as nonsense when read by the equipment of another freight-handling system. Compatibility in this respect is not required, and in some situations may not even be desired. Also, centralized systems, because they must cover the entire territory of an airline or freight system, must have enormous data-processing capabilities in order to keep track of enormous numbers of bags or packages: a single computer system must in effect be able to "cover" airports on several continents in the case of an international airline, or more likely several computers on different continents must be able to readily communicate with each other and be able to access large amounts of data from each other if necessary. As airlines and freight systems grow, the necessary capability of a "core" central control unit for handling freight will require a proportional amount of memory and other computing capability.

In the prior art, U.S. Pat. No. U.S. Pat. No. 4,068,232 discloses a tracking system in which the objects being tracked, such as cargo and trailers, are provided with passive transponders. When the objects having the transponders move through an interrogator beam, some of the beam's energy powers the transponder, which generates a signal bearing unique transponder information. The transponder information can then be decoded to derive an identification number for the object.

U.S. Pat. No. U.S. Pat. No. 4.217,588 discloses a road-navigation system wherein "signpost" units are positioned at predetermined geographical locations. Each signpost unit transmits a binary code for reception in units installed in moving vehicles. The units receive the signpost codes from adjacent signposts in order to determine the location of the vehicle. The units are operable in an automatic reporting mode, in which the location of the monitored vehicles is reported only when the vehicle enters a different coverage region, a region or route reporting mode, wherein only vehicles within a predetermined region or on a predetermined route report to the base station, and in a polling mode, wherein only the locations of predetermined monitored vehicles are reported to the base station.

U.S. Pat. No. U.S. Pat. No. 4,275,385 discloses a personnel locator system wherein persons carry battery-powered transmitters which emit unique infrared identification codes. The infrared transmission is received by overhead infrared receivers in a building. The transmitter's identification code together with the receiver identification code is communicated to a common control unit which displays the location of all of the transmitter units.

U.S. Pat. No. U.S. Pat. No. 4,658,357 discloses a wrist-transmitter that transmits a code signal every fifteen seconds so the wearer can be located by one of a set of short-range receivers. The location information can be received and logged, and report on the behavior of the wearer generated.

U.S. Pat. No. U.S. Pat. No. 4,688,026 discloses a system wherein different locations and objects are assigned tags which are capable of wirelessly transmitting unique codes when energized by RF energy. A user searching for an object moves an RF antenna sufficiently close to the tag to energize it and cause the tag to transmit its code.

U.S. Pat. No. U.S. Pat. No. 4,952,928 discloses a personnel monitoring system which includes a transponding unit that is worn or carried by the individual being monitored. Periodically or on request, the transponder unit transmits a unique signal that identifies the person being monitored. The system can also be used to monitor activities of the person being monitored, such as heart rate or muscle movement.

U.S. Pat. No. U.S. Pat. No. 5,027,314 discloses a tracking system wherein one transmitter is associated with each subject being tracked. Each transmitter transmits a light based signal representing a unique identifying code. Receivers are associated with each of a plurality of geographical areas. A central processing member connected to each of the receivers records electrical signals derived from the light-based signals from each unique transmitter.

U.S. Pat. No. U.S. Pat. No. 5,122,959 discloses a vehicle dispatch system wherein a plurality of work stations each contains a digitized map base of different vehicle delivery areas. The system calculates minimum travel time based upon a tree-node decision algorithm, and selects vehicles for various pick-ups and deliveries.

The present invention provides a system by which each package in a freight-tracking system is provided with an intelligent agent, in the form of a "tag" including a microprocessor, by which, in effect, each individual package is responsible for routing itself, so that the need for central control of individual packages in a system is minimized or obviated.

According to one aspect of the present invention, there is provided a method of managing a plurality of non-self-propelled packages in a distribution system. A package transceiver is physically asscoaited with each package. A location transceiver is disposed at each of a plurality of fixed nodes in the distribution system. Each location transceiver communicates a unique location code to a package transceiver at the node. Each package transceiver is programmed with a destination code representative of a location in the distribution system where the package is intended to be disposed. The package transceiver transmits an activity

signal in response to receiving the location code of the location transceiver related to the destination code.

According to another aspect of the present invention, there is provided a tracking apparatus adapted to be attached to a non-self-propelled package, comprising a transceiver and a processor operatively associated with the transceiver. The processor retains a destination code representative of a location in the distribution system where the package is intended to be disposed, recognizes a location code broadcast from an external location transceiver, and transmits an activity signal in response to recognizing a location code of the location transceiver related to the destination code.

In the Drawings:

FIG. **1** is a simplified systems view of a typical freight-distribution system utilizing different aspects of the tracking system of the present invention;

FIG. **2** is a simplified systems diagram showing the essential functionality of a tag according to the present invention; and

FIG. **3** is an illustration of how the tracking system of the present invention can be cascaded for different applications.

FIG. **1** is a simplified systems view of a typical freight-distribution system utilizing different aspects of the tracking system of the present invention. A series of packages, such as indicated by **10**, enter the system at an input point such as **12**, from which the series of packages are loaded on a system of conveyors generally indicated as **14**, with the different branches of the conveyor system being indicated as **14***a*, **14***b*, and **14***c*. The invention is generally directed to handling of non-self-propelled packages, as opposed to vehicles. The branches **14***b* and **14***c* of conveyor **14***a* split at a diverter **16**. As used in the claims herein below, any point in the tracking system deemed important for the tracking process can be designated a "node." In the illustrated example, a package **10** entering the system at input port **12** can be selectably directed to one of six destination nodes, here indicated by letters A–F. These destination nodes may represent, for example, bulk containers to be loaded onto a plane going to a particular destination, or trucks backed at a loading dock, etc. The symbol associated with each destination letter A–F indicates that there is associated, at some point geographically related to the destination, such as a loading dock or a bulk container, a radio transceiver **20**, indicated by the antenna symbol on each destination node A–F. Also, the area of the system just before the diverter **16** can be designated a "node" as well, and is here shown with a transceiver representing an input node I.

The general principle behind the present invention is that each package is ultimately responsible for its own fate in the distribution system, as opposed to a centralized system in which each package being tracked is a passive object under the control of a central control system. Each package **10** has permanently associated therewith a transceiver, or "tag" **100**, which may have different subsystems as will be described in detail below, which essentially includes a transceiver and a microprocessor. The transceiver can be of a radio or infrared-communication type, and is adapted for short-range communication with other transceivers within a reasonable geographical vicinity of the package at any time. The microprocessor associated with the transceiver in tag **100** is capable of sending and/or understanding coded messages through the transceiver. As used in the claims herein, a "transceiver" shall mean an apparatus which is capable of receiving or transmitting a signal, even through in certain embodiments a particular transceiver will be called upon for only one such function.

Upon entering the distribution system, the package **10**, with its associated tag **100**, can be queried at an input transceiver I. The input transceiver I broadcasts to the tag **100** a query message which solicits, in the microprocessor in tag **100**, a response to the input transceiver I in which the tag **100** of package **10** essentially says "I want to go to [for example] destination node D." In the context of a distribution center, destination node D may represent a bulk container for a plane or truck going to a particular city.

Input transceiver I can be operatively connected to any portion of a downstream conveying system which can influence the input package **10** reaching its desired destination. In the present embodiment, input transceiver I is operatively connected to a diverter **16** at a transfer node, which can divert a particular package **10** to either conveyor **14***b* or **14***c*, depending on the desired ultimate destination. If the desired destination node for a package **10** is D, input transceiver I can influence diverter **16** to divert the package **10** to conveyor **14***c*. This is an example of a situation wherein information from the tag **100** influences external equipment to direct the package.

The tag **100** associated with the package **10** can also be used to respond to external stimuli in order to ensure the package **10** is routed to the desired destination. According to one embodiment of the present invention, the transceiver associated with each destination node A–F continuously broadcasts, such as by radio signals an identification code. When received by an appropriate transceiver on a package such as **10**, the essential meaning of the message broadcast by the transceiver **20** associated with a destination node is "you are at destination node - - - " The transceivers **20** associated with the destination nodes provide signals which can be received by the tags **100** physically associated with each package **10**. For example, the package **10**, having been diverted at node **16** onto conveyor **14***c*, will be exposed to broadcast signals from the transceivers **20** for destination nodes such as D–F along conveyor **14***c*. In the present example, it is desired that the package **10** end up at destination node D; therefore, it is to be expected that, once the package **10** reaches destination D along conveyor **14***c*, the package will remain at destination node D for an appreciable length of time, and therefore the transceiver in tag **100** associated with package **10** will be receiving the broadcast signal from the transceiver at destination node D for an appreciable length of time as well. Further, the transceiver in tag **100** will not be exposed for long periods to the broadcast signals from non-desired destination nodes: the transceiver on tag **100** should only be exposed to non-desired broadcast signals for the short amount of time in which the package passes the transceiver of a non-desired destination node in route to another node.

The fact that a tag **100** of a package **10** is intended to be exposed only briefly to non-desired destination node broadcast signals, and receives the broadcast signal of the desired destination code for an extended period of time, can be exploited for various purposes. If the package **10** is moving along a conveyor system, the tag **100** can interact with both the broadcast signal at the destination node and any ancillary equipment to divert the package toward the destination node along the conveyor. For example, if the package **10** is desired to be sent to destination node D, the tag **100** can respond to receiving the broadcast signal from the destination node D with sending an instruction to ancillary equipment along conveyor belt **14***c* that, in effect, "this is my stop, let me off here." In other words, at destination node D (or at any other destination node) the transceiver **20** associated with the destination node not only broadcasts its identity, but is also sensitive to signals from the tags on the packages, which can be interpreted to indicate that an apparatus such

as generally indicated by **22** can push the package **10** off of the conveyor **14***c* and into long-term association with destination node D (i.e., by pushing the package **10** into the bulk container, or depositing the package **10** by a particular loading dock, so that the tag **100** receives the broadcast signal from transceiver **20** at destination node D for a reasonably extended length of time).

The underlying concept oil the present invention, that each package has associated therewith its own "intelligent" tag which retains the desired destination of the package, presents fundamental advantages over prior-art systems. First, in many freight-tracking systems in current use, packages entering a system are provided with a passive routing system, such as a bar-code sticker which is provided by the proprietor of the distribution system. Typically, these bar-codes or other passive tags are (1) provided by the system proprietor on a mass-production basis, and (2) dedicated to the particular tracking system used by the system proprietor. The key disadvantage of (1) is that when a non-interested person types in the package destination data for a large series of packages to create bar-codes, the chance of human error over a large series of packages is relatively high. The disadvantage of (2) is that different distribution systems run by different entities tend to be incompatible with each other. For example, the Post Office, private air-freight companies, airlines, and internal systems used by users of these systems are all mutually exclusive.

The advantages of the present system include the fact that the tag **100** for a package **10** is assigned a desired destination before it enters the distribution system, typically by the owner of the package and not the proprietor of the tracking system. Because the owner of the package has a greater interest in avoiding mistakes in programming the destination of the package, the chance of error in entering a destination is significantly reduced. The combination of transceiver and microprocessor in tag **100** can also be used to maintain the package in some type of contact with the owner of the package even as the package moves through a distribution system owned by someone else. It will be noted in FIG. **1** that a truly centralized tracking system, in control of every node illustrated in FIG. **1**, is not necessary to realize the system: the system controlling, for example, node D does not have to know about nodes E or F. Indeed, more nodes G, H, J (not shown) can be added at the end of conveyor **14***c* without any effect on the operation of transceiver **20** or diverting equipment **22** at node D. In prior-art systems, there would probably have to be some master controller influencing, ultimately, every node in the system. All that has to be known by the control system at input port I is that certain nodes are located along conveyor **14***b* and others are located along **14***c*; of course, if one wanted a purely linear system in which all nodes are along the same conveyor, even this input node I would be unnecessary.

FIG. **2** is a simplified systems diagram showing the essential functionality of a tag **100** for use with the present invention. The tag **100** generally comprises a low-power microprocessor, such as generally indicated by **200**, in combination with a radio or infrared transceiver indicated as **202**. Both microprocessor **200** and transceiver **202**, under typical conditions, can be manufactured in a relatively small package which can be readily attached to a package, or buckled to a handle of a suitcase, for example. It will further be evident that the tag **100** can include its own power source, such as a battery (not shown). The following description will show that a great deal of systemic functionality can be achieved using relatively simple detection-and-response algorithms on a microprocessor for each tag **100**. The smaller boxes within the dotted box indicating microprocessor **200** are intended indicate the basic functionality of algorithms programmed onto microprocessor **200**.

According to the basic aspect of the present invention, the tag **100** of a particular package need only be programmed to recognize two types of external signals: a destination code, which is unique to any local destination node broadcasting a signal, and also, according to another aspect of the invention, a query code, which is a special code which, when received, will cause the microprocessor **200** to send out information identifying itself. With reference to FIG. **1** above, when the receiver portion of transceiver **202** receives a signal which is recognized as the broadcast signal of a desired destination for the package, the microprocessor **200** will respond to this desired destination signal, as shown at the function marked **210**, by transmitting what is here called an "activity signal." The activity signal is a signal to nearby equipment that the package is at its destination, and that ancillary equipment at the destination should take the package, or otherwise perform some relevant physical action on the package. Referring back to FIG. **1**, an example of this "activity" is commanding local equipment to push the package off the conveyor belt at the desired location. This activity signal can be very general in meaning (i.e., "take me") and local equipment such as a conveyor belt or robot arm can respond as necessary to this activity signal. The package itself does not care exactly how it is handled in response to the transmission of an activity signal.

It may also be desirable, in some situations, that the microprocessor **200** recognize receiving a query signal from an external source, such as at the input node of a distribution system as shown in FIG. **1**. Like the activity signal, the query signal can be of great generality in meaning (i.e., "tell me where you are going") and, in response to receiving this query code, the microprocessor **200** will cause to be transmitted through transceiver **202** at least a destination code, as shown by the function marked **212**. By eliciting the destination code, an external system can direct the package to its destination. Although it may be possible that the microprocessor **200** could transmit more information, such as a unique package identification code, or the name and address of the sender, this extra information is generally not necessary for operation of the system, and in fact there may be a desire to keep individual packages anonymous. Generally all that a distribution system is interested in is the destination of the package, and not its origin.

The microprocessor **200** of tag **100** can also be made sensitive to situations in which it is believed that something has gone wrong, and each individual tag **100** can take steps to flag the error. For example, the microprocessor **200** may be provided with a timer, and may suspect something is wrong when a predetermined relatively long period of time has passed without receiving any proper destination code, or by receiving a wrong destination code for a predetermined period of time. In either case, the microprocessor may be recognizing a situation in which either the package has fallen out of the system completely (by no longer being in range of any node transceiver) or has been directed to the wrong destination (because it is consistently receiving broadcast signals from the transceiver of a non-desired destination node). In this case, microprocessor **200** is programmed to transmit, through transceiver **202** or otherwise, a "distress signal." In a basic sense, a tag **100**, finding itself out of the system completely, or not at its desired destination within a few days, can emit a distress signal in the form of an audible signal emitted through a speaker (not shown). Alternately, the microprocessor **200** may try to make contact

with its owner through means which can circumvent the short-range infrared or radio communication of the transceiver, by using the transceiver not for its usual purpose but for contacting its owner directly, such as through a cellular phone contact, illustrated as **216**. In such a situation, microprocessor **200** can literally "call up" its owner and send a message which can be interpreted as "I have not yet reached my destination." In this way, a tag **100** can circumvent not only the physical freight-handling system, but can circumvent the proprietor of the freight-handling system, such as the airline or freight company, and report directly to its owner.

The microprocessor **200** also includes provision, indicated at **218**, for entering the destination code onto the tag **100** before it is attached to a package and sent. This entry of the destination code can be performed either through the transceiver **202**, or, preferably, through a jack and wire (not shown) forming part of the tag itself. Other parameters, such as expected length of delivery time (which will effect when distress signals will be sent out) can be entered as well.

For purposes of each tag **100** being able to locate itself with some desirable degree of precision over time, an important modification to the basic invention would be to program both the general system and the individual microprocessor to hunt for a "hierarchical" recognition of broadcast signals at various nodes. For example, if in an air-freight system, regular zip codes are used to identify destinations, the fact that zip codes are not randomly distributed, but rather associated with specific regions of the country, can be exploited. For example, if a sender in zip code 14644 in New York desires to send a package to, zip code 94304 in California, and the various nodes through the country are each provided with transceivers that merely broadcast the local zip code, microprocessor **200** can be programmed to, for example, transmit a distress signal if, after three days, the first number of the local zip code is not 9, or if the zip code it is currently receiving does not begin with 943. A system could be provided which causes the tag **100** to transmit its last-received zip code or destination code with its distress signal, along with the time of last receipt of any such broadcast signal.

Another key advantage of the present invention is that the system is expandable for applications not only within a distribution within a single building, but can be extended into a world-wide system. FIG. **3** shows packages such as **10** with associated tags **100**, loaded respectively in bulk containers **50**, which in turn can be disposed within an airplane, as shown, or in a truck. It will be noted that, in both the airplane and the truck, the bulk container **50** has associated therewith a transceiver tag **102**. The tag **102** operates in the same manner as the tags **100** associated with each package **10**. The tags **100** associated with each package **10** can, by their close proximity, communicate with the tags **102** associated with bulk packages **50**. Similarly, either tag **100** or tag **102** can interact with a tag **104** which is associated with either the airplane or the truck. Further, the tags **104** associated with the airplane or truck can conceivably communicate with a large-scale transceiver such as **106** which is permanently associated with, for example, a destination city. The tags such as **102**, **104**, and **106** can broadcast destination codes which are cascaded through each respective tag so that a tag **100** associated with a package **10** can detect, by the nature of the broadcast signals it receives, that a package is or is not in the right bulk container, that the bulk container is on a truck or airplane intended for the correct destination, and that the truck or airplane is indeed heading toward the correct destination.

The above illustrated embodiments of the system of the present invention are directed to the most basic aspects of such a system, showing the general communication between "smart" tags or transceivers associated with packages interacting with transceivers associated with geographical points along a route. However, there, may be incorporated a number of sophisticated variations to enhance the performance and versatility of such a system. Below are described a number of modifications to the above-described basic system, which can be incorporated, for example, as further instructions within microprocessor **200**. These modifications allow the tags to interact in more complex ways with the routing stations.

One variation of the system of the present invention is to provide in a memory, such as shown as **230**, associated with microprocessor **200** of each tag **100** information not only about the ultimate destination of the package, but a sequence of destinations, i.e., location codes for a sequence of routing stations that must be taken from the sender's location to the desired ultimate destination. That is, for a package sent from California to Zimbabwe, it is likely that such a package will be first placed on a truck, sent to a distribution center, placed on another truck, taken to an airport, and taken on a series of airplanes, etc. on its way. Under the system of the present invention, the sender in California can map out a desired sequence of steps such as truck **1**, distribution center **1**, truck **2**, airplane **1**, distribution center **2**, airplane **2**, etc., into the memory associated with microprocessor **200**. In this way, the sender not only "addresses" the package by entering the ultimate destination in memory, but rather maps out a specific route, as defined as a set of trucks, distribution centers and airplanes, etc., as a set of directions from the sender's location to the destination. If the package tag **100** has in memory **230** the full set of instructions to arrive at its destination, the tag could communicate, for example, to a UPS truck that the next point it wanted to go to was the airport, and not any further information which UPS would have no control over, such as instructions involving the airline, or the Zimbabwean Postal Service. By providing information in the tag at a low level of specificity, such as which truck to get on, what plane to get on, etc., as much intelligence as possible for determining where the package will go will remain with the package tag.

By placing the low-level instructions in the tags themselves, the individual routing stations at fixed points in a system can therefore be made as a "passive" as possible. This would lower the amount of information that would have to be stored at each individual routing station in a system. Another advantage of placing most of the intelligence on the tags, as opposed to at fixed routing stations, is that the design can be scaled to large systems that allow multiple independent transport services, such as postal services and airlines, to cooperate with each other. It is generally less expensive to add instructions in non-volatile memory on each tag, each tag instructing its immediate environment where it wants to go in the short term (a particular truck, for example) than to provide each routing station with relatively sophisticated decision making capabilities.

Putting a relatively large amount of information on the package tag also enables the concept of corrective rerouting. Under one variation to the system of the present invention, a tag interacts with nearby routing stations to have itself rerouted back to its correct route when misrouting is detected, such as by the presence of incongruous, or unknown location codes detected by the tag. Rerouting could be accomplished, for example, by having the tag

record the set of routing stations that it has passed and then constructing a modified route for itself by tracing its actual route back to the last location code that was correct and then continuing on with the remainder of the correct route that was originally programmed therein. Once the tag detects that it is not on the right route, such as by not receiving a particular location code in is pre-programmed series of location codes after a certain period of time, the transceiver can contact the nearest external transciever (such as at a particular node) and signal to be sent back to the node associated with the last correct location code.

Another variation to the system of the present invention is to provide for broadcast by a given tag special information about the package, such as whether the package is fragile or contains dangerous materials. If the tag forewarns a particular location that, for example, it is highly flammable, the location could be programmed to refuse the package, or select for the package an alternate route. An airport baggage router may wish to reroute packages broadcasting an "I'm fragile" message to a special conveyor belt that is manned by humans who could place the package on the airplane carefully.

Another possible variation to the above-described system is to provide a rescheduling system on each tag. For example, if a tag associated with a package is waiting to be placed on an airplane, but the airplane is delayed, the tag could "ask" to be placed instead on a different flight, perhaps, even on a different airline. For a highly tag-based system, each tag is provided with its own real-time clock and access to airline schedules, with freight rates. A tag programmed to get its package to a certain destination can access (such as through the transceiver **202**, or a separate infrared link, not shown) a schedule to its memory **230** and then look for the next available flight on any airline, or else compare all available flights within a certain time frame, such as the next **24** hours, and choose the least expensive one. In a more general sense, it is conceivable, using the basic principle of the above-described invention, to devise a system in which decisions can be made at each individual tag to select a route to a desired destination which can individually adjust to changing circumstances, particularly if the tag is provided either by external communication or by information pre-programmed in memory **230**, with information about cost alternatives, particularly among competing transport services. (In the claims herein, a schedule, such as of flights, is defined as comprising a list of "transports," a transport being hereby defined broadly as a transportation option. Thus, a tag having access to airline, postal, and trucking schedules could conceivably make comparisons among different modes of transportation.) Also, such a "costing" system may take into account non-monetary costs in deciding on a route: for example, the route chosen by a tag may try to minimize cost given that the package must arrive by a certain date and time, or the route chosen by a tag may take into account features such as "registered mail" versus ordinary delivery guarantees.

Finally, it is conceivable, using a variation of the basic principle of the present invention, to provide a system for electronic payment of transport costs via each package tag. If package tags can dynamically take advantage of changing circumstances, such as comparative costs of different transport systems, in order to change their routing, then it is likely that the cost that must be finally paid to transport any given package will have to be calculated by the processor in the tag. Given suitable support for electronic cash transfers, it is conceivable to provide a system in which packages pay for each segment of their journey as that segment is taken. One basic technique by which such a pay-as-you-go system is facilitated is to have each package tag **100** transmit a "payment signal" of an identifiable code to external apparatus, such as to a location transceiver **20** at a desired destination node, such as at a particular airport or in a truck belonging to a particular transport service. The payment signal is transmitted in response to the tag recieving the desired location code. The effect of an appropriate payment signal, which may include a field for the amount of money to be paid for the leg of the journey, on the location transceiver **20** would be to record a payment between a proprietor of the package and a proprietor of the location node. Such a system would avoid the trouble of separate billing, and billing changes as rerouting decisions occur, among independent transport services. If an electronic funds management feature within the above-described system is constructed, it may be required that individual tags have particular features, such a security and tamper prevention.

A designer of a system according to the present invention will choose a level of generality for instructions on each tag which is most useful under given constraints. If relatively detailed instructions are placed on each tag, such as a list of what specific trucks or aircraft the package is to be loaded on in what sequence, more "passive" devices can be placed in geographical locations along the routes in a system, but more sophistication will be required on each tag, and the programmer of the tag must know in advance what route is to be taken to the destination. If a system is provided in which all the sender must program on a tag is on the level of "Be at this address in Texas within 48 hours," either the equipment along the route must be endowed with decision-making capabilities, or the tag itself must have automated access to information which will enable the tag to automatically plan its own route, such as airline schedules, etc. Also, the decision of what level of generality will be accepted by a tag will further depend on how "universal" a system is desired, i.e., on to what extent tags must be compatible with disparate systems owned by different proprietors.

In order to maintain a long life of the battery used on a tag **100**, a communication transceiver that powers on only when within range of a location transceiver can be used. The transceiver can use a low-power sensing mechanism that detects the presence of a suitable field that is emanated by each location transceiver. Detection of this field causes the tag to power up its more power-hungry communications transceiver for regular sending and receipt of messages. Low-power field sensing devices of the sort described are well known to practitioners of the field of wireless communications.

While this invention has been described in conjunction with various embodiments, it is evident that many alternatives, modifications, and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications, and variations as fall within the spirit and broad scope of the appended claims.

We claim:

1. A method of managing a plurality of non-self-propelled packages in a distribution system, comprising the steps of:

physically associating with each package a package transceiver including a processor associated therewith;

disposing at each of a plurality of fixed nodes in the distribution system a location transceiver, each location transceiver adapted to communicate a unique location code to a package transceiver at the node;

programming each processor with a destination code representative of a location in the distribution system where the package is intended to be disposed; and

a package transceiver transmitting an activity signal in response to receiving a location code of a location transceiver related to the destination code.

2. The method of claim 1, further comprising the step of the activity signal causing an external apparatus at the node related to the destination code to perform a physical act on the package.

3. The method of claim 2. further comprising the step of the activity signal causing an external apparatus at the node related to the destination code to cause the package to be retained near the node.

4. The method of claim 1, the programming step including the step of programming each processor with a sequence of location codes representative of a series of locations in the distribution system where the package is intended to be disposed; and further including the step of

a package transceiver transmitting an activity signal in response to receiving the location code of the location transceiver related to a destination code in the sequence.

5. The method of claim 1, further comprising the step of

a package transceiver transmitting a signal consistent with the package associated therewith requiring special handling.

6. The method of claim 1, further comprising the steps of

a location transceiver transmitting a query code to a package transceiver in a predetermined physical relationship with the location transceiver;

the package transceiver in said predetermined physical relationship with the location transceiver transmitting the destination code programmed therein in response to said query code;

said destination code causing an external apparatus to direct the package associated with said package transceiver toward a node associated with said destination code.

7. The method of claim 1, further comprising the step of a package transceiver transmitting a distress signal in response to not receiving the location code of the location transceiver related to the destination code after a predetermined time period.

8. The method of claim 7, the step of transmitting a distress signal including the step of the package transceiver emitting an audible signal.

9. The method of claim 7, the step of transmitting a distress signal including the step of the package transceiver transmitting a message via a cellular telephone system.

10. The method of claim 7, the step of transmitting a distress signal including the step of transmitting a location code last received by the package transceiver.

11. The method of claim 1, the programming step including the step of programming each package transceiver with a sequence of location codes representative of a series of locations in the distribution system where the package is intended to be disposed; and further comprising the steps of:

a package transceiver transmitting an activity signal in response to receiving the location code of the: location transceiver related to a location code in the sequence; and

in response to not receiving the location code of the location transceiver related to a location code at a predetermined position in the sequence of location codes after a predetermined time period, the package transceiver transmitting an activity signal consistent with causing external equipment to move the package associated with the package transceiver to a location consistent with a previous location code in the sequence.

12. The method of claim 1, further comprising the steps of

a package transceiver transmitting a payment signal in response to receiving the location code of the location transceiver related to the destination code; and

an external apparatus related to the destination code accepting the payment signal, the payment signal having an effect of recording a payment between a proprietor of the package and a proprietor of the external apparatus.

13. The method of claim 1, further comprising the steps of

a package transceiver accessing data relating to a schedule of a transport system for transporting the package, the schedule comprising a list of available transports; and

the package transceiver transmitting an activity signal consistent with causing external equipment to move the package associated with the package transceiver to a location consistent with the, package being placed on a selected transport from the schedule.

14. The method of claim 13, further comprising the steps of

the package transceiver accessing data relating to a schedule of a transport system for transporting the package, the, schedule comprising a list of available transports and costs associated with each transport; and

the package transceiver taking into account a cost of each possible transport to select a transport from the schedule.

15. A tracking apparatus adapted to be attached to a non-self-propelled package within a distribution system, comprising:

a transceiver; and

a processor operatively associated with the transceiver, the processor including

means for retaining a destination code representative of a location in the distribution system where the package is intended to be disposed,

means for recognizing a location code broadcast from an external location transceiver, and

means for transmitting an activity signal in response to recognizing a location code of the location transceiver related to the destination code.

16. The apparatus of claim 15, the processor further including

means for recognizing a query code broadcast from an external location transceiver, and

means for transmitting the destination code programmed therein in response to said query code.

17. The apparatus of claim 15, the processor further including means for transmitting a distress signal in response to not receiving the location code of the location transceiver related to the destination code after a predetermined time period.

18. The apparatus of claim 17, the means for transmitting a distress signal including means for transmitting a message via a cellular telephone system.

19. The apparatus of claim 17, the means for transmitting a distress signal including means for transmitting a location code last received by the package transceiver.

20. The apparatus of claim 15, further comprising

means for retaining a sequence of location codes representative of a series of locations in the distribution system where the package is intended to be disposed; and

means for transmitting a distress signal in response to not receiving a location code in the sequence of location codes after a predetermined time period.

21. The apparatus of claim 15, attached to a container holding a second package therein, the second package attached to a second tracking apparatus including a second transceiver and a second processor, the second processor including means for recognizing a location code,

the processor further including means for broadcasting a unique location code to said second tracking apparatus associated with said second package.

22. The apparatus of claim 21, the processor further including

means for broadcasting a query code to said second tracking apparatus, the second tracking apparatus further including means for transmitting a destination code programmed therein in response to receiving said query code; and

means for recognizing a destination code transmitted by said second tracking apparatus.

23. The apparatus of claim 15, the processor further comprising

means for accessing data relating to a schedule of a transport system for transporting the package, the schedule comprising a list of available transports; and

means for transmitting an activity signal consistent with causing external equipment to move the package associated with the package transceiver to a location consistent with the package being placed on a selected transport from the schedule.

24. The apparatus of claim 23, further comprising

means for accessing data relating to a schedule of a transport system for transporting the package, the schedule comprising a list of available transports and costs associated with each transport; and

means for taking into account a cost of each possible transport to select a transport from the schedule.

* * * * *

US006634560B1

(12) **United States Patent**
Grabau

(10) **Patent No.: US 6,634,560 B1**
(45) **Date of Patent: Oct. 21, 2003**

(54) **RADIO FREQUENCY IDENTIFICATION TAGGING, ENCODING/READING THROUGH A DIGITIZER TABLET**

(75) Inventor: **Robert E. Grabau**, Tonawanda, NY (US)

(73) Assignee: **Moore North America, Inc.**, Grand Island, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/460,572**

(22) Filed: **Dec. 14, 1999**

(51) **Int. Cl.**[7] **G06K 19/06**
(52) **U.S. Cl.** **235/492**; 235/472.01
(58) **Field of Search** 235/492, 375, 235/379, 380, 472.01–472.02; 340/10.1, 10.4, 41, 42; 705/3, 4, 35, 38, 39

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,902,858 A		2/1990	Yamanami et al.	178/19
5,107,541 A	*	4/1992	Hilton	382/3
5,278,399 A	*	1/1994	Sano	235/462.45
5,294,792 A	*	3/1994	Lewis et al.	250/221
5,297,202 A	*	3/1994	Kapp et al.	380/9
5,528,222 A	*	6/1996	Moskowitz et al.	340/572
5,541,399 A	*	7/1996	De Vall	235/491
5,554,827 A	*	9/1996	Oda	178/18
5,629,499 A	*	5/1997	Flickinger et al.	178/18
5,734,129 A	*	3/1998	Belville et al.	178/18
5,748,779 A	*	5/1998	Sakaguchi	382/203
6,147,662 A	*	11/2000	Grabau et al.	343/894
6,206,292 B1	*	3/2001	Robertz et al.	235/488
6,215,401 B1	*	4/2001	Brady et al.	340/572.7
6,222,452 B1	*	4/2001	Ahlstrom et al.	340/572.1

FOREIGN PATENT DOCUMENTS

DE	19601358 A		7/1996
JP	01-142819	*	6/1989

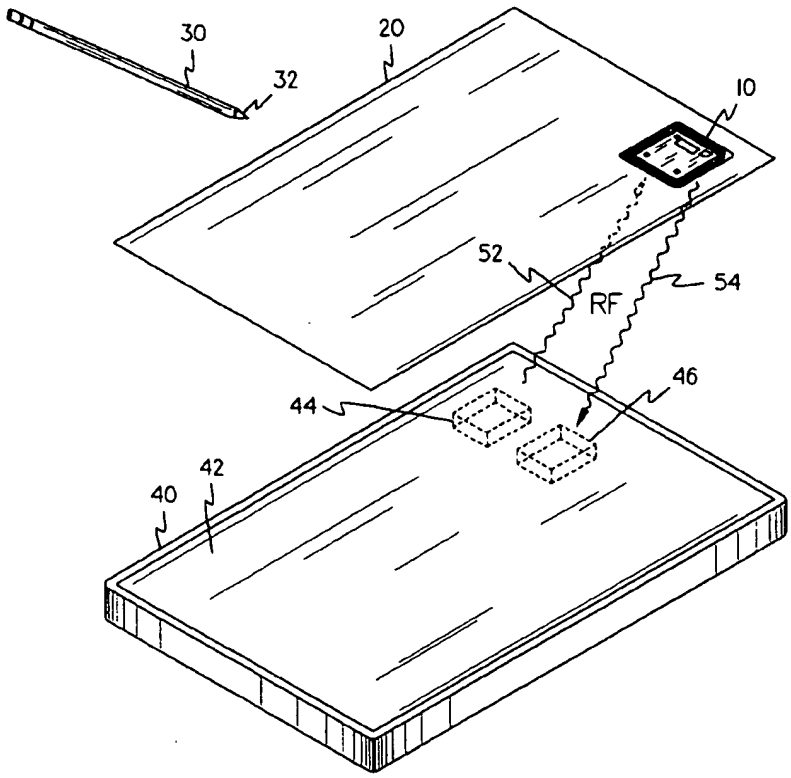
* cited by examiner

Primary Examiner—Diane I. Lee
(74) *Attorney, Agent, or Firm*—Simpson & Simpson, PLLC

(57) **ABSTRACT**

A communication device including a digitizer pad and a substrate including a radio frequency tag, where the tag and the digitizer pad are operatively arranged to communicate with each other. A method of communication between a radio frequency identification tag, preferably secured to a business form, and a digitizing tablet.

18 Claims, 5 Drawing Sheets



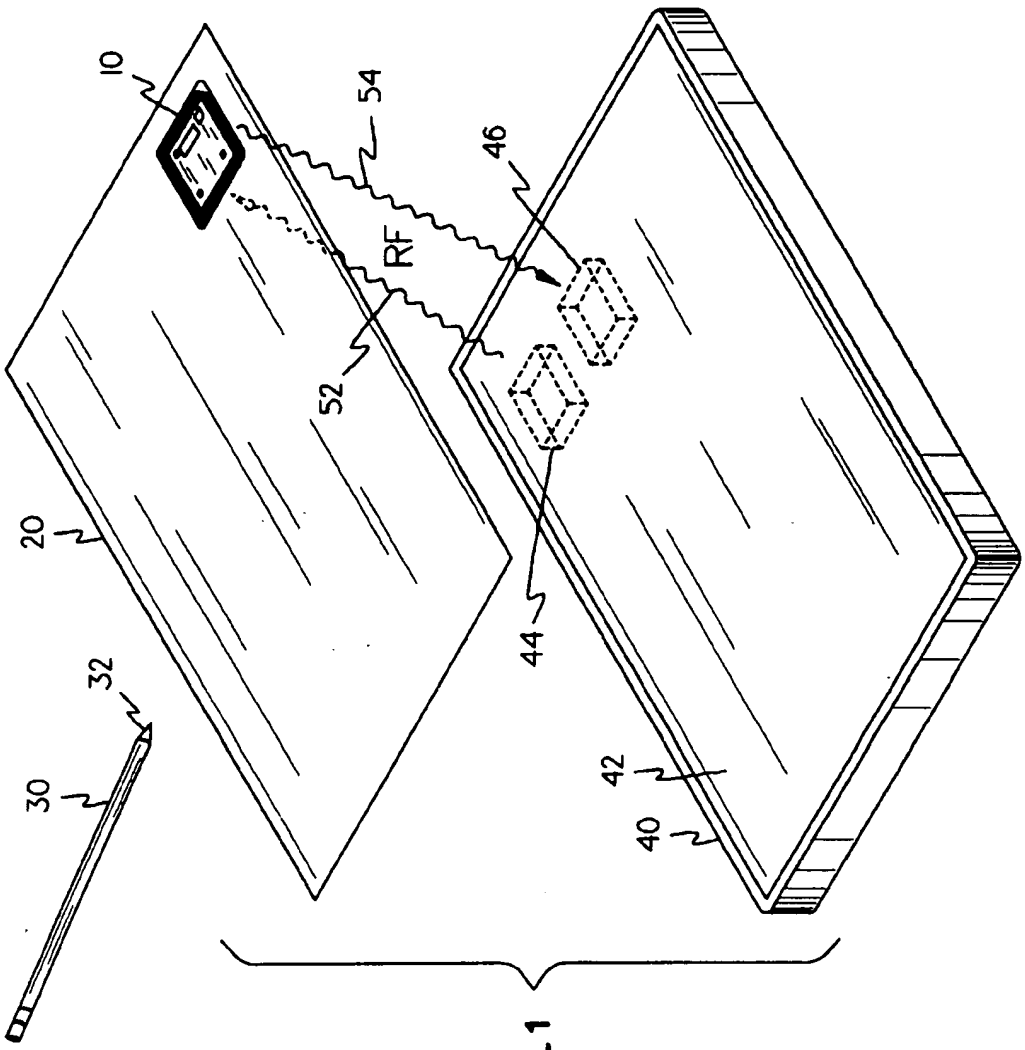


Fig. 1

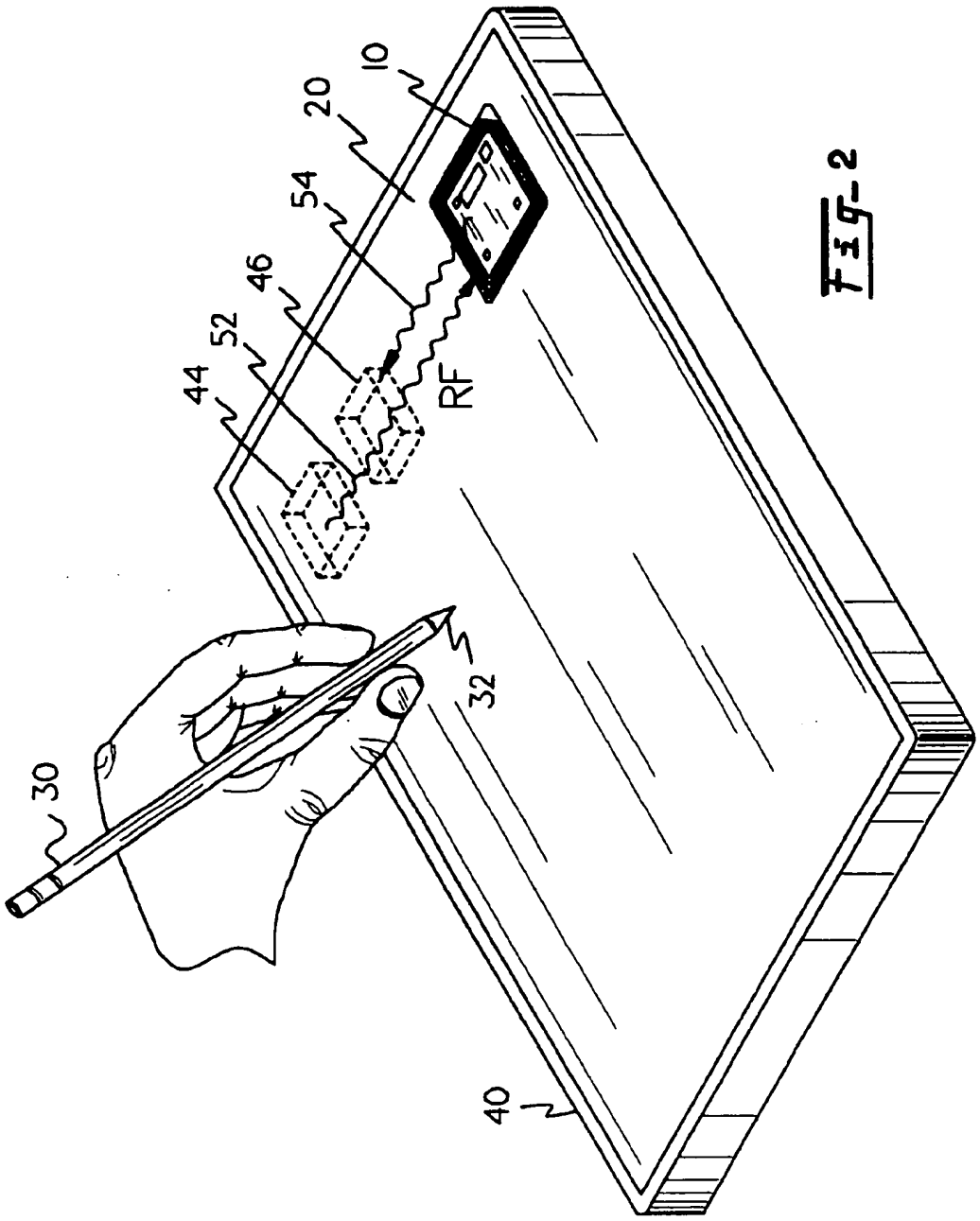


Fig. 2

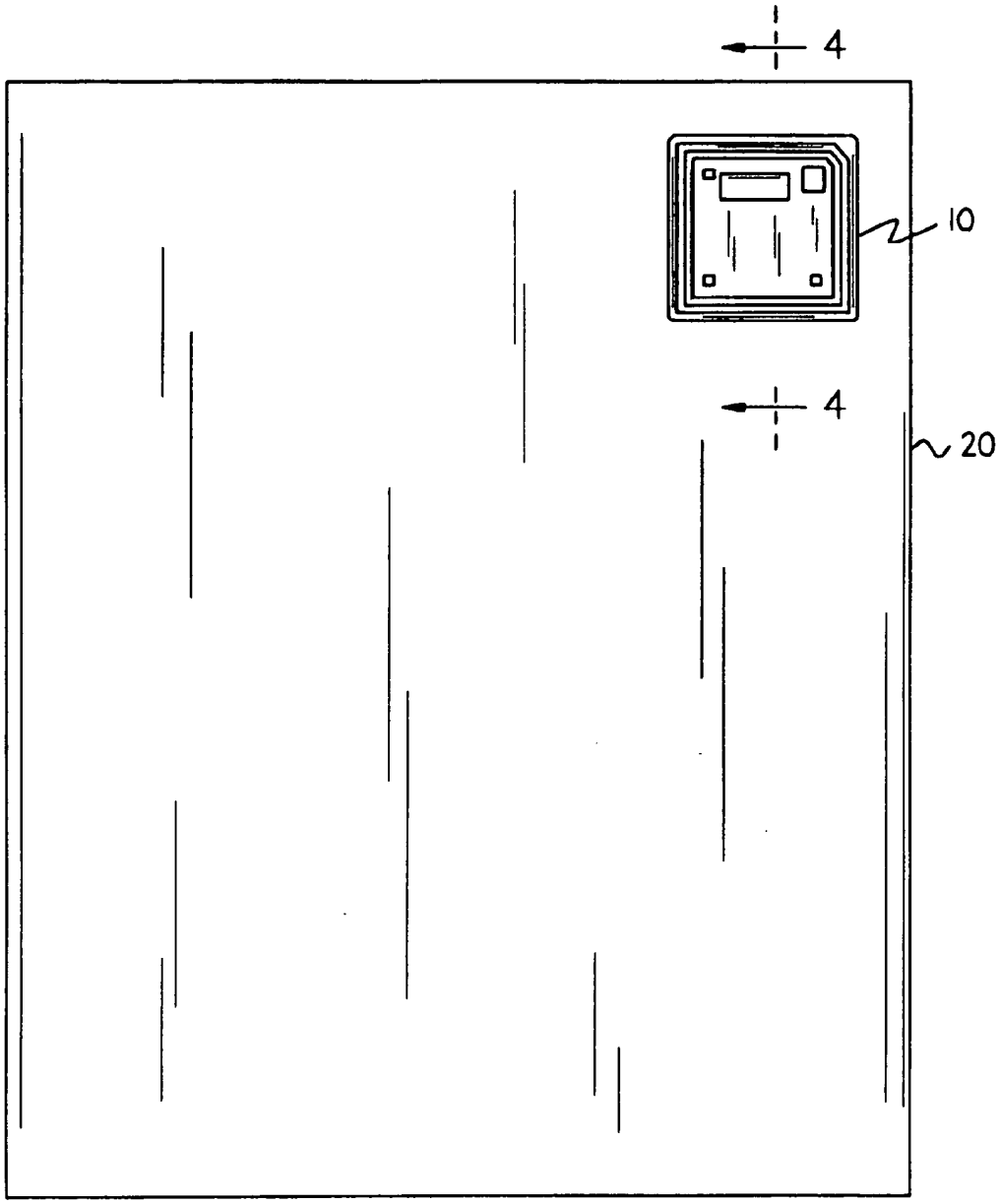


Fig. 3

Fig. 4

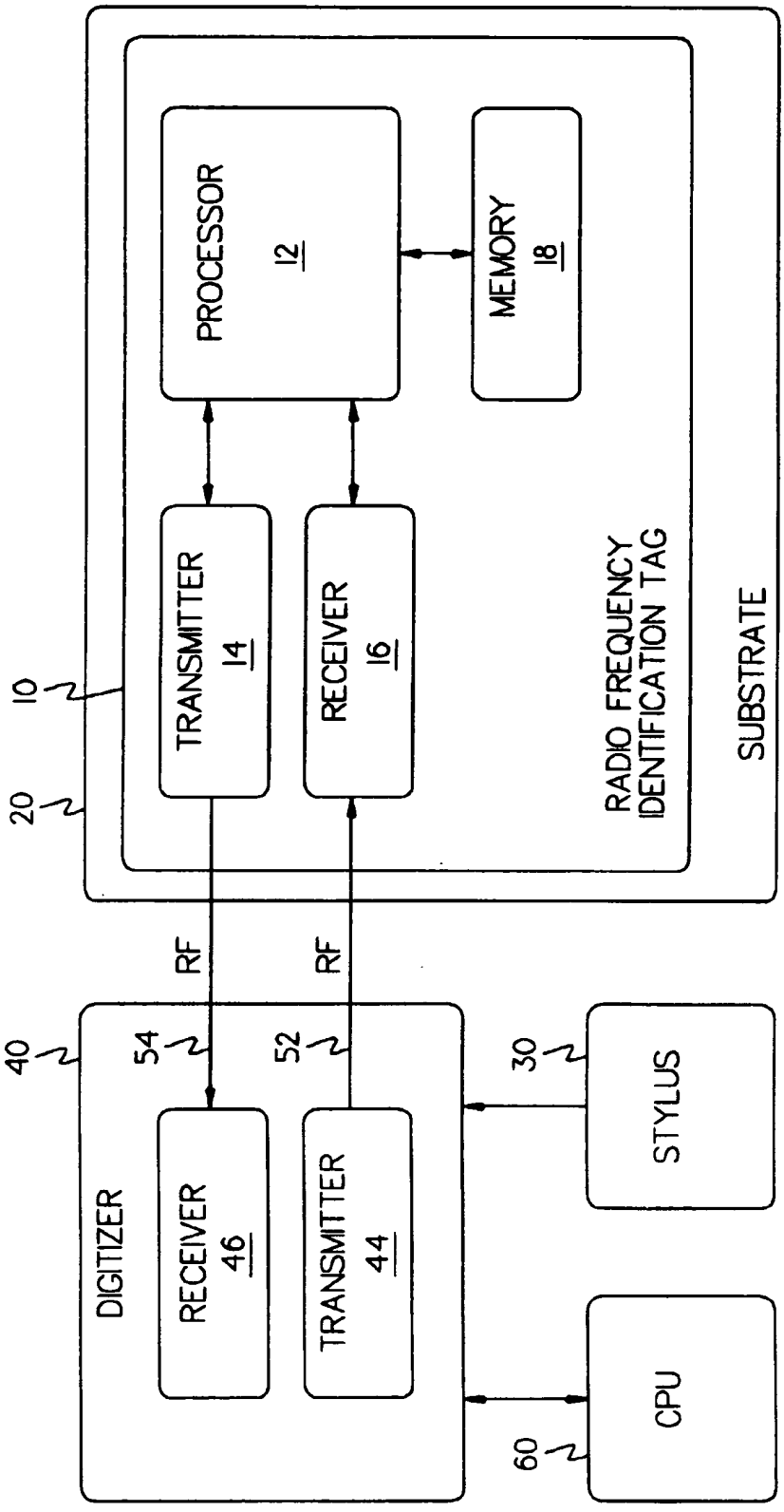

PROCESSOR
12
MEMORY
18
TRANSMITTER
14
RECEIVER
16
RADIO FREQUENCY
IDENTIFICATION TAG
SUBSTRATE
10
20
RF
RF
40
54
52
30
DIGITIZER
RECEIVER
46
TRANSMITTER
44
STYLUS
CPU
60

Fig. 5

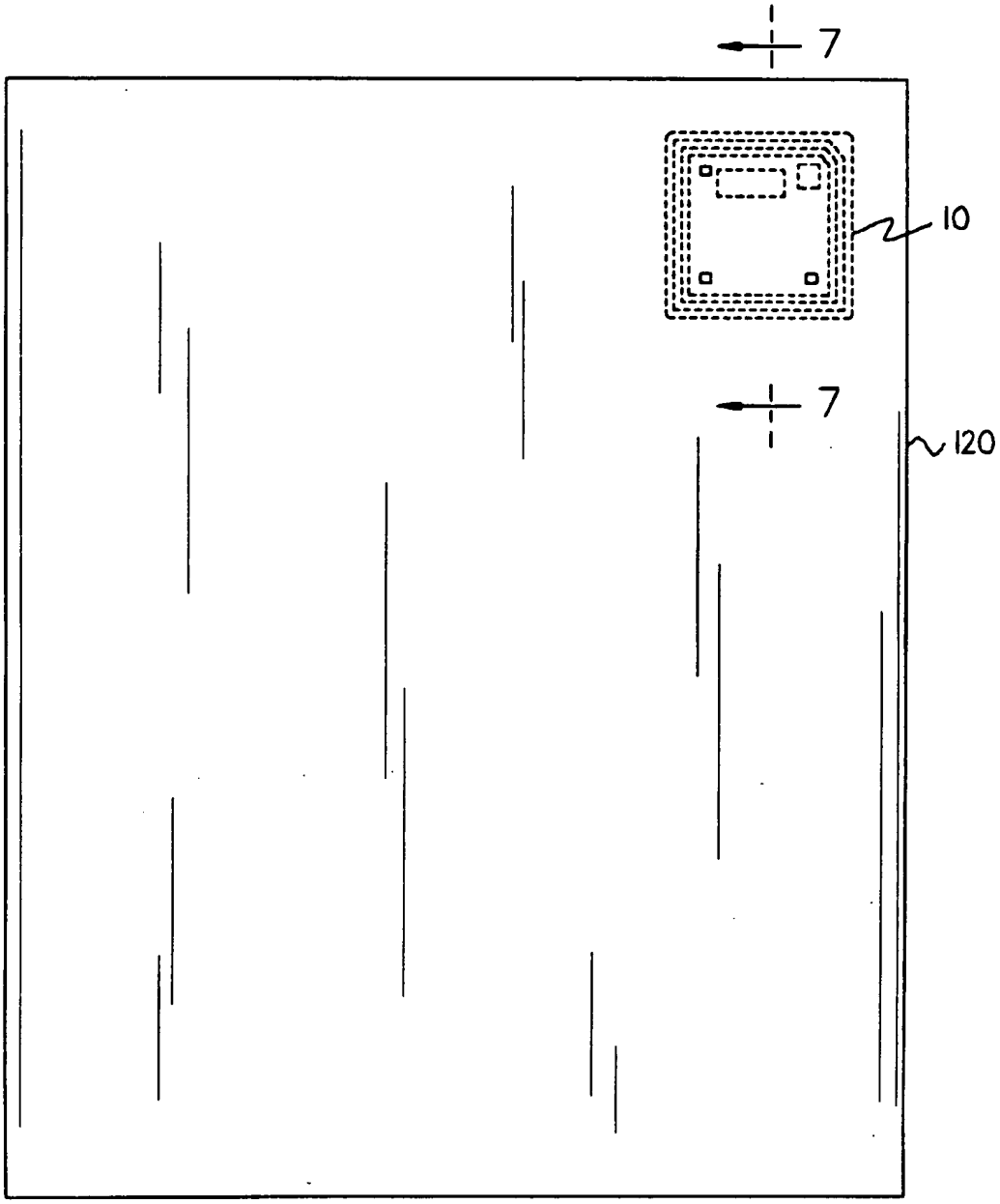


Fig. 6

Fig. 7

RADIO FREQUENCY IDENTIFICATION TAGGING, ENCODING/READING THROUGH A DIGITIZER TABLET

FIELD OF THE INVENTION

This invention relates generally to radio frequency identification tagging (RFID) and digitizing tablets and, more particularly, to a combination RFID/digitizing tablet.

BACKGROUND OF THE INVENTION

Radio frequency identification tagging is a known method of identification. An information carrying device, or tag, functions in response to a coded radio frequency (RF) signal transmitted from a base station. The RF carrier signal reflects from the tag and can be demodulated to recover information stored in the tag. The tag typically includes a semiconductor chip having RF circuits, logic, and memory, as well as an antenna. Various tag structures, circuits, and programming protocols are known in the art. Examples are described in U.S. Pat. No. 5,682,143 (Brady et al.) and 5,444,223 (Blama), both of which are incorporated herein by reference.

Although RFID tags are not yet as prevalent as other identification means (e.g., barcode) due to the cost of tags and their relative bulkiness, RFID tags are gaining in popularity in various applications. These include railway boxcar and tractor trailer identification schemes, fare cards for buses and subways, animal identification, employee and security badges, and in automatic highway toll systems. In an automatic highway toll system in place for the New York State Thruway, for example (EZ Pass), drivers mount an RFID tag on the front vehicle windshield. The tag is preprogrammed with driver information, such as account status, vehicle information, etc. As the vehicle passes through a toll, a base transmitter at the tollbooth emits a signal which is reflected by the RFID tag. If the driver's account is satisfactory, a green light activates; indicating the driver is free to pass through the toll.

Digitizer tablets (also known as digitizer pads or digital pads) are also well known in the art. A digitizer tablet is a computer-input device which captures an analog image impressed upon a surface of the tablet and converts the image into a digital representation thereof. A typical digitizer tablet includes a pressure sensitive element and a pen-like writing stylus. The electronic pressure sensitive elements senses the position of the stylus on the tablet and reports it (perhaps 100 times per second or more) to a computer. Digitizing tablets are used in computer aided drafting (CAD) applications, to record signature images in electronic commerce, and in certain biometrics signature verification schemes (a method of verifying the signer's identity by assessing indicators such as line shape and stylus pressure). Digitizing tablets are also used as input devices for computer games, keyboards, graphics display inputs and the like.

Digitizing tablets capable of sensing two-dimensional spatial parameters are well known in the art. More recently, tablets capable of sensing three-dimensional parameters (e.g., two spatial parameters plus pressure of the stylus) have been developed. An example of such a three dimensional digitizing tablet is disclosed in U.S. Pat. No. 4,810,992 (Eventoff), incorporated herein by reference.

Although both RFID and digitizing tablets have both been known in the art, heretofore, apparently no one has combined an RFID with a digitizing tablet. There has existed a longfelt need for such a device, with many applications in business.

SUMMARY OF THE INVENTION

The invention broadly comprises a communication device including a digitizer pad and a substrate including a radio frequency tag, where the tag and the digitizer pad are operatively arranged to communicate with each other. The invention also includes a method of communication between a radio frequency identification tag, preferably secured to a business form, and a digitizing tablet.

A general object of the invention is to provide a communication link between a digitizing pad and a radio frequency identification tag.

Another object is to provide a business form containing a radio frequency identification tag in combination with a digitizing tablet operatively arranged to communicate with the radio frequency identification tag.

A further object is to provide a means and method for communicating useful information about a business form to a digitizing tablet prior to, or concurrently with, the form being placed upon the tablet for communication via the tablet stylus.

These and other objects, features and advantages of the present invention will become readily apparent to those having ordinary skill in the art in view of the following detailed description in view of the several drawing figures and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective elevational view of the invention, showing the radio frequency identification tag (RFID) attached to a substrate, the digitizing tablet, and the stylus;

FIG. **2** is a perspective view of the invention, illustrating the RFID tag attached to a substrate, with the substrate in place on the digitizing tablet;

FIG. **3** is a plan view of the substrate containing the RFID shown in FIGS. **1** and **2**;

FIG. **4** is an enlarged partial cross-sectional view of the substrate and RFID, taken generally along lines **4—4** of FIG. **3**;

FIG. **5** is a block diagram of the electronic and radio frequency circuit of the invention;

FIG. **6** is a plan view of an alternative embodiment of the substrate of the invention; and,

FIG. **7** is a partial cross-sectional view of the substrate and RFID, taken generally along lines **7—7** of FIG. **6**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

At the outset, it should be clearly understood that like reference numerals are intended to identify the same structural elements, portions or surfaces consistently throughout the several drawing figures. as such elements, portions or surfaces may be further described or explained by the entire written specification, of which this detailed description is an integral part. Unless otherwise indicated, the drawings are intended to be read together with the specification, and are to be considered a portion of the entire "written description" of this invention.

FIG. **1** is an exploded perspective elevational view of the invention. The invention broadly comprises digitizing tablet **40** in combination with substrate **20**, which substrate includes radio frequency identification tag (RFID) **10**. The digitizer includes a pressure sensitive top surface **42**. Stylus **30** having stylus tip **32** can be used to communicate input

signals to surface **42**. The substrate can be manufactured from a variety of different materials, such as paper, plastic and the like. The nature of the material and general structure of the substrate is immaterial to the present invention. The substrate could, for example, comprise a single sheet of paper. It could comprise a business form, either single ply, or multi-ply. It may be a carbonless form, or be a multi-part form having sections separable and detachable.

RFID **10** is secured to substrate **20**. In the embodiment shown in FIGS. **1–4**, the RFID is surface-mounted to the substrate. Once again, it is immaterial to the invention as to how, or even where, the RFID is secured or attached to the substrate. Any means of attachment known to those having ordinary skill in the art may be used. In the embodiment shown, the RFID is positioned in the top right-hand portion of the substrate, although it could be positioned at another location. In practice, the RFID placement on the substrate is dictated by the design and function of the substrate itself. For example, the RFID (if surface mounted) might be placed as to avoid printed indicia on a business form. This would not be necessary if the RFID was embedded within the substrate, as in an alternative embodiment described infra.

The RFID itself may comprise a number of forms. For example, both of the radio frequency identification tags described in the aforementioned U.S. Pat. Nos. 5,444,223 and 5,682,143 would be suitable for the present invention, although other RFID devices would also be suitable.

In some RFIDs, for example, the device is passive and merely reflects the transmitted signal back to the source. The incoming signal is processed by a semiconductor/logic circuit within the RFID, and causes impedance changes which then modulates the RF signal. This modulation allows the tag to send useful information back to the base station. In other RFID designs, the device may include an internal power supply, and/or its own transmitter and receiver units.

As shown in FIG. **1**, as the substrate approaches the digitizing tablet, transmitter **44** in the tablet sends a radio frequency (RF) signal **52** which is received by the RFID. The RFID then transmits signal **54** back to receiver **46** in the tablet, which signal contains certain information about the substrate. (In practice, the RFID may be a passive device, and merely reflect the original signal back to the transmitter/receiver of the digitizing tablet, where the reflected signal has been modified in some way to convey information back to the digitizing tablet. Also, the transmitter/receiver in the tablet may be embodied in an integral unit.) For example, the information can include a unique identifier for the substrate, an operator number, a location code, an inventory control code, etc. It is not necessary that the substrate be actually placed on the digitizing tablet for the communication to begin, although the maximum distance between the tablet and RFID for effective communication is largely determined by signal strength and antenna design.

As shown in FIG. **2**, once the substrate is positioned atop the digitizing tablet, the stylus **30** can be used to further transmit information through the substrate to the pressure sensitive surface of the tablet. The point **32** of the stylus sends signals through the pressure sensitive layer to a processor. The substrate is shown in plan view in FIG. **3**. Again, although this view shows the RFID placed in the top right-hand section of the substrate, this position is not critical. It could be placed elsewhere on the substrate. Also, as shown in FIG. **4**, which is a partial cross-sectional view of the substrate and RFID taken generally along lines **4—4** of FIG. **3**, RFID **10** is surface mounted atop surface **22** of substrate **20**. An alternative embodiment is shown in FIGS. **6** and **7**. In this embodiment, as shown in FIG. **6**, the RFID is still placed in the top right-hand section of the substrate but, as shown in the cross-sectional view of FIG. **7** (taken generally along lines **7—7** of FIG. **6**, RFID is embedded within substrate **120**. The embedding can be accomplished in a number of ways known in the art. For example, the RFID could be secured to the substrate by perforations or die-cuts, or secured between plies of a multi-ply substrate.

FIG. **5** illustrates a block diagram of the communication paths of the invention. RFID **10** is shown to comprise transmitter **14**, receiver **16**, processor **12**, and memory **18**. Digitizing tablet **40** comprises transmitter **44** and receiver **46**, which communicate with RFID receiver **16** and transmitter **14**, respectively, via radio frequency signals. Stylus **30** also communicates with digitizer **40**, which signals are communicated to remote processor **60**. Again, this block diagram is representative of but one of many different possible circuit embodiments of the invention. The RFID, for example, may not include an internal memory. It may include a separate power supply, or none at all. It may have a single antenna used both for reception and reflection of the RF signal.

Thus, it is seen that the objects of the invention are efficiently obtained, although changes and modifications to the invention may be made without departing from the scope and spirit of the invention as described in the appended claims.

What is claimed is:

1. A communication device, comprising:

a digitizer tablet comprising communication means and a pressure sensitive top surface; and

a substrate comprising a business form and a radio frequency identification tag, wherein said substrate and said digitizer tablet are operatively arranged for communication.

2. A communication device as recited in claim **1**, wherein said substrate is made of paper.

3. A communication device as recited in claim **1** wherein said radio frequency identification tag is mounted atop a surface of said substrate.

4. A communication device as recited in claim **1** wherein said radio frequency identification tag is integral with said substrate.

5. A communication device as recited in claim **1** wherein said radio frequency identification tag is flush mounted to said substrate.

6. A communication device as recited in claim **1** wherein said digitizer tablet includes a radio frequency transmitter operatively arranged to transmit a radio frequency signal to said radio frequency identification tag.

7. A communication device as recited in claim **1** wherein said digitizer tablet includes a radio frequency receiver operatively arranged to receive a radio frequency signal reflected from said radio frequency identification tag.

8. A communication device as recited in claim **1** wherein said digitizer tablet includes a radio frequency receiver operatively arranged to receive a radio frequency signal transmitted from said radio frequency identification tag.

9. A communication device, comprising:

a digitizer tablet comprising communication means and a pressure sensitive top surface; and

a substrate comprising a business form and a radio frequency identification tag, wherein said substrate and said digitizer tablet are operatively arranged for communication and said radio frequency identification tag is programmed with information relative to said business form.

10. A method of communication, comprising:

transmitting a radio frequency signal from a transmitter in a digitizer tablet having a pressure sensitive top surface;

reflecting said radio frequency signal from a radio frequency identification tag,

where said radio frequency tag modulates said radio frequency signal to include information; and

receiving said radio frequency signal by a receiver in said digitizer tablet.

11. A method of communication as recited in claim **10** wherein said radio identification tag is secured to a substrate.

12. A method of communication as recited in claim **11** wherein said substrate comprises a business form.

13. A method of communication as recited in claim **10** further comprising the step of demodulating said radio frequency signal.

14. A method of communication, comprising:

transmitting a first radio frequency signal from a transmitter in a digitizer tablet having a pressure sensitive top surface;

receiving said first radio frequency signal by a radio frequency identification tag;

transmitting a second radio frequency signal by said radio frequency identification tag in reply to the reception of the first radio frequency signal; and

receiving said second radio frequency signal by a receiver in said digitizer tablet.

15. A method of communication as recited in claim **14** wherein said radio identification tag is secured to a substrate.

16. A method of communication as recited in claim **15** wherein said substrate comprises a business form.

17. A method of communication as recited in claim **14** further comprising the step of demodulating said radio frequency signal.

18. A communication device, comprising:

a digitizer tablet comprising communication means and a pressure sensitive top surface; and

a paper substrate comprising a radio frequency identification tag, wherein said substrate and said digitizer tablet are operatively arranged for communication.

* * * * *